WORKSHOP MANUAL

FOCS Engine Series

cod. 1-5302-351

UNI EN ISO 9001 - cert. n° 0446
ISO/TS 16949 - cert. n° 3792

LOMBARDINI SERVICE
A KOHLER COMPANY

FOCS Engine Series

PREFACE

- Every attempt has been made to present within this service manual, accurate and up to date technical information.
  However, development on the **LOMBARDINI** series is continuous.
  Therefore, the information within this manual is subject to change without notice and without obligation.

- The information contained within this service manual is the sole property of **LOMBARDINI**.
  As such, no reproduction or replication in whole or part is allowed without the express written permission of **LOMBARDINI**.

Information presented within this manual assumes the following:

1 - The person or people performing service work on **LOMBARDINI** series engines is properly trained and equipped to safely and professionally perform the subject operation;

2 - The person or people performing service work on **LOMBARDINI** series engines possesses adequate hand and **LOMBARDINI** special tools to safely and professionally perform the subject service operation;

3 - The person or people performing service work on **LOMBARDINI** series engines has read the pertinent information regarding the subject service operations and fully understands the operation at hand.

- This manual was written by the manufacturer to provide technical and operating information to authorised **LOMBARDINI** after-sales service centres to carry out assembly, disassembly, overhauling, replacement and tuning operations.

- As well as employing good operating techniques and observing the right timing for operations, operators must read the information very carefully and comply with it scrupulously.

- Time spent reading this information will help to prevent health and safety risks and financial damage.
  Written information is accompanied by illustrations in order to facilitate your understanding of every step of the operating phases.

LOMBARDINI SERVICE
A KOHLER COMPANY

REGISTRATION OF MODIFICATIONS TO THE DOCUMENT

Any modifications to this document must be registered by the drafting body, by completing the following table.

Drafting body	Document code	Model N°	Edition	Revision	Issue date	Review date	Endorsed
CUSE/ATLO	1-5302-351	50563	**7°**	**6**	04-90	15.03.2008	

This manual contains pertinent information regarding the repair of LOMBARDINI water-cooled, indirect injection Diesel engines type ~~LDW 502 602 903 1204 1204/T~~ **e LDW** ~~**702 1003**~~**-1404**: updated March 15th, 2006.

CHAPTER INDEX

1 GENERAL REMARKS AND SAFETY INFORMATION ..... Pag. 9 - 11

GENERAL SAFETY DURING OPERATING PHASES 11
GENERAL SERVICE MANUAL NOTES 9
GLOSSARY AND TERMINOLOGY 9
SAFETY AND ENVIRONMENTAL IMPACT 11
SAFETY AND WARNING DECALS 10
SAFETY REGULATIONS 10-11
WARRANTY CERTIFICATE 9

2 TECHNICAL INFORMATION 12-23

MANUFACTURER AND ENGINE IDENTIFICATION 14-15
OVERALL DIMENSION 21-23
PERFORMANCE DIAGRAMS 18-20
TECHINICAL SPECIFICATIONS 16-17
TROUBLE SHOOTING 12-13

3 MAINTENANCE - RECOMMENDED OIL TYPE - REFILLING 24-27

ACEA Regualtions - ACEA Sequences 25
API / MIL Sequence 25
COOLANT 27
FUEL SPECIFICATIONS 27
International specifications 25
LUBRICANT 25
PRESCRIBED LUBRICANT 26
ROUTINE ENGINE MAINTENANCE 24
SAE Classification 25

4 DISASSEMBLY / REASSEMBLY 28-65

Air filter support 30
Air restriction switch 29
Alternator/Cooling fan belt drive 33
Big end bearing 58
Camshaft journals and housings - Dimensions 47
Camshaft lobe measurement 47
Camshaft timing - Belt Reassembly 37
Camshaft timing - Belt Tightening and Fastening 38
Camshaft timing - Belt tightening tool 38
Camshaft timing pulley - Disassembly/Assembly 37
Camshaft timing pulley - Reference marks 37
Camshaft, disassembly 46
Camshaft, journal and housing measurement 46
Central main bearing caps 60
Check the clearances between the bearings and the journal 60
Clearances between the bearings and corresponding pins 64
CONNECTING ROD 58
Connecting rod alignment 59
Connecting rod with bearings and pin 58
Connecting tod, weight 58
Cooling fan 33
Crankcase breather LDW 502 44
Crankcase vacuum regulator valve 43
Crankshaft axial clearance 61
Crankshaft front and back oil seal rings 62

Crankshaft timing pulley 36
Crankshaft, check journals and crank 63
Crankshaft, lubrication lines 63
Cylinder head assembly 57
Cylinder head tightening procedure LDW 1204-1204/T-1404 57
Cylinder head tightening procedure LDW 502-602-702-903-1003 57
CYLINDER HEAD, removal 48
Cylinder roughness 59
Cylinder, class 59
CYLINDERS 59
Driving pulley 34
Dry type air filter 29
E.G.R. Circuit 30-31
Exhaust maniflod 32
Flywheel 34
Fuel rail 44
Fuel tank (optional) 33
Governor springs 40
Governor springs for Gensets 40
Head gasket 56
Hydraulic pump drive 65
Injection pump control rod 44
Intake / Exhaust / Injection camshaft lobe height - LDW 903 47
Intake manifold – Remote air filter 30
Journal and connecting rod pins diameters 63
Main bearings and connecting rod big ends diameters 64
Oil bath air cleaner (on request) 29
Oil pan, removal 52
Oil pump - disassembly 42
Oil pump - Reassembly 42
PISTON 52
Piston clearance 55
Piston coolant nozzles 61
Piston ring, Clearance between grooves 54
Piston ring, mounting order 55
Piston rings - End gaps 54
Piston, assembly 55
Piston, class 53
Piston, disassembly and inspection 53
Piston, weight 54
Pre-combustion chamber 51
Pre-combustion chamber ring nut removal 51
Pre-combustion chamber, installation 51
Pre-combustion chamber, removal 51
Pump/injector unit - Disassembly 45
Pump/injector unit - non-return valve 45
Rear and forward main bearing caps 60
RECOMMENDATIONS FOR DISASSEMBLING AND ASSEMBLING 28
RECOMMENDATIONS FOR OVERHAULS AND TUNING 28
Return pulley 34
Ringfeder-type rings on LDW 1204-1204/T-1404 35
Ringfeder-type rings on LDW 1204-1204/T-1404 - Assembly 35
Rocker arm assembly 45
Rocker arm cover 42
Rocker arm cover gasket 43
Rocker arm pivot, dismounting and remounting 46
Shoulder half rings 61
Shoulder half rings, oversized elements 62
Speed governor 40
Speed governor - Limiting speed governor 41
Speed governor - Reassembly 41
Speed governor components 40
Stop pin rings, dismounting and remounting 52
Third drive, components 65
Tightening pulley 36
Timing belt / Timing pulley arrangement 36
Timing belt cover 35

Timing belt removal 36
Vacuum pump and vacuum pump flange 33
Valve / Rocker arm clearance 44
Valve guide insertion 49
Valve guides and valve guide housings 49
Valve recess and seat sealing width 50
Valve seats and housings - Dimensions 50
Valve springs 48
Valve stem sealing rings - Reassembly 48
Valve timing - Angles 39
Valve timing check 38
Valve, specifications 49
Valves 48

5 ~~TURBOCHARGER~~ ..... ~~66-67~~

~~TURBO CHARGER ..... 66~~
~~Turbocharger components ..... 66~~
~~Turbocharger pressure testing ..... 66~~
~~Turbocharger west gate adjustment - Regolazione corsa asta comando valvola " Waste gate " ..... 67~~

6 LUBRIFICATION CIRCUIT 68-71

Internal oil filter and oil sump return pipe 69
LUBRIFICATION CIRCUIT 68
Oil filter cartridge 70
Oil pressure check 70
Oil pressure regulating valve 70
Oil pump 69
Oil pump, clearance between rotors 69

7 COOLANT CIRCUIT 72-73

COOLANT CIRCUIT 72
Coolant circulation pump, components 73
Radiator and compensation, check and seal tank cap. 73
Thermostatic valve 73

8 FUEL SYSTEM 74-83

Closing the oilhole 82
Fuel feeding / injection circuit 74
Fuel filter detached from the tank (on request) 74
Fuel lift pump 74
Fuel pump drive rod projection 74
Injection advance control and regulation 80
Injection advance for currently used pump/injector unit 80
Injection advance references on timing belt protector 81
Injection pump assembly/disassembly 76
Injection pumps delivery balancing 83
Injector, nozzle projection 79
Injector, setting (old type) 79
Injector, spark arrester 79
Instrument connection 83
Plunger barrel ring nut assembly/disassembly 76
Plunger injection pump reassembly 76
Preliminary steps to pump/injector unit delivery balancing test 82
Pump/injector unit 75
Pump/injector unit se.no. 6590.285 control data. 77-78
Pump/injector unit, components 75
Pumping element 77
Pumping element (old-type injection pump) 77

Setting of injector according to current pump/injector unit 79
Static injection advance regulation 82
Static injection advance tuning 81
TDC (Top Dead Center) references 81
Test head B assembly 82
Tester and special coupling for injection advance control (Old-type injection pump) 81

9 ELECTRIC SYSTEM 84-93

Alternator battery charger curve 12V 20A 89
Alternator battery charger curve 12V 30A 89
Alternator, Iskra 14V 33A 85
Alternator, Iskra 14V 33A - Performance Curve 85
Alternator, Marelli type AA 125 R 14V 45A 87
Alternator, Marelli type AA 125 R 14V 45A - Performance Curve 87
Coolant high temperature lamp sensor 93
ELECTRIC CONTROL PANEL WITH AUTOMATIC ENGINE STOP 84
Electric starting layout (12V) with flywheel alternator 90
Electric starting layout (12V) with Iskra alternator 14V 33A 86
Electric starting layout (12V) with Marelli type AA 125 R 14V 45A alternator 88
Flywheel Alternator 88
Oil pressure switch 93
Pre-heating glow plug 92
Pre-heating glow plug control unit with coolant temperature sensor 92
STARTER MOTOR - Bosch DW 12V 1,1 KW 91
Starter motor, Bosch 12V 1,6 Kw 91
Starter motor, Bosch DW 12V 1,1 KW - Performance Curve 91
Starter motor, Bosch DW 12V 1,6 KW - Performance Curve 92
Temperature sensor for control unit 93
Voltage regulator connections 90

10 SETTINGS 94-97

E.G.R. calibration 97
Injection pump flow limiter and standard engine torque gearing device 95
Pump injection delivery standard setting without dynamometric brake 94
Pump/injector unit delivery setting with braked engine 96
Pump/injector unit timing with speed governor 95
Required settings (as most commonly applies) 96
Setting the idle maximum (standard) 94
Setting the idle minimum (standard) 94
Setting the stop 95
SPEED SETTINGS 94

11 STORAGE 98-99

ENGINE STORAGE (NOT INSTALLED) 98
PREPARING THE ENGINE FOR OPERATION AFTER PROTECTIVE TREATMENT 99
PROTECTIVE TREATMENT 98

12 TORQUE SPECIFICATIONS AND USE OF SEALANT 100-101

Table of tightening torques for standard screws (coarse thread) 101
Table of tightening torques for standard screws (fine thread) 101
Table of tightening torques for the main components 100

13 SPECIAL TOOLS 102

WARRANTY CERTIFICATE

- The products manufactured by Lombardini Srl are warranted to be free from conformity defects for a period of 24 months from the date of delivery to the first end user.
- For engines fitted to stationary equipment, working at constant load and at constant and/or slightly variable speed within the setting limits, the warranty covers a period up to a limit of 2000 working hours, if the above mentioned period (24 months) is not expired.
- If no hour-meter is fitted , 12 working hours per calendar day will be considered.
- For what concerns the parts subject to wear and deterioration (injection/feeding system, electrical system, cooling system, sealing parts, non-metallic pipes, belts) warranty covers a maximum limit of 2000 working hours, if the above mentioned period (24 months) is not expired.
- For correct maintenance and replacement of these parts, it is necessary to follow the instructions reported in the documentation supplied with each engine.
- To ensure the engine warranty is valid, the engine installation, considering the product technical features, must be carried out by qualified personnel only.
- The list of the Lombardini authorized dealers is reported in the “Service” booklet, supplied with each engine.
- Special applications involving considerable modifications to the cooling/lubricating system (for ex.: dry oil sump), filtering system, turbo-charged models, will require special written warranty agreements.
- Within the above stated periods Lombardini Srl directly or through its authorized network will repair and/or replace free of charge any own part or component that, upon examination by Lombardini or by an authorized Lombardini agent, is found to be defective in conformity, workmanship or materials.
- Any other responsibility/obligation for different expenses, damages and direct/indirect losses deriving from the engine use or from both the total or partial impossibility of use, is excluded.
- The repair or replacement of any component will not extend or renew the warranty period.

Lombardini warranty obligations here above described will be cancelled if:

- Lombardini engines are not correctly installed and as a consequence the correct functional parameters are not respected and altered.
- Lombardini engines are not used according to the instructions reported in the “Use and Maintenance” booklet supplied with each engine.
- Any seal affixed to the engine by Lombardini has been tampered with or removed.
- Spare parts used are not original Lombardini.
- Feeding and injection systems are damaged by unauthorized or poor quality fuel types.
- Electrical system failure is due to components, connected to this system, which are not supplied or installed by Lombardini.
- Engines have been disassembled, repaired or altered by any part other than an authorized Lombardini agent.

- Following expiration of the above stated warranty periods and working hours, Lombardini will have no further responsibility for warranty and will consider its here above mentioned obligations for warranty complete.

- Any warranty request related to a non-conformity of the product must be addressed to the Lombardini Srl service agents.

GENERAL SERVICE MANUAL NOTES

1 - Use only genuine Lombardini repair parts.
Failure to use genuine Lombardini parts could result in sub-standard performance and low longevity.

2 - All data presented are in metric format. That is, dimensions are presented in millimeters (mm), torque is presented in Newton-meters (Nm), weight is presented in kilograms (Kg), volume is presented in liters or cubic centimeters (cc) and pressure is presented in barometric units (bar).

GLOSSARY AND TERMINOLOGY

For clarity, here are the definitions of a number of terms used recurrently in the manual.

- **Cylinder number one:** is the timing belt side piston .
- **Rotation direction:** anticlockwise «viewed from the flywheel side of the engine».

SAFETY AND WARNING DECALS

- Important remarks and features of the text are highlighted using symbols, which are explained below:

Danger – Attention

This indicates situations of grave danger which, if ignored, may seriously threaten the health and safety of individuals.

Caution – Warning

This indicates that it is necessary to take proper precautions to prevent any risk to the health and safety of individuals and avoid financial damage.

Important

This indicates particularly important technical information that should not be ignored.

SAFETY REGULATIONS

- **LOMBARDINI** Engines are built to supply their performances in a safe and long-lasting way.
  To obtain these results, it is essential for users to comply with the servicing instructions given in the relative manual along with the safety recommendations listed below.
- The engine has been made according to a machine manufacturer's specifications and all actions required to meet the essential safety and health safeguarding requisites have been taken, as prescribed by the current laws in merit.
  All uses of the engine beyond those specifically established cannot therefore be considered as conforming to the use defined by **LOMBARDINI** which thus declines all liability for any accidents deriving from such operations.
- The following indications are dedicated to the user of the machine in order to reduce or eliminate risks concerning engine operation in particular, along with the relative routine maintenance work.
- The user must read these instructions carefully and become familiar with the operations described.
  Failure to do this could lead to serious danger for his personal safety and health and that of any persons who may be in the vicinity of the machine.
- The engine may only be used or assembled on a machine by technicians who are adequately trained about its operation and the deriving dangers.
  This condition is also essential when it comes to routine and, above all, extraordinary maintenance operations which, in the latter case, must only be carried out by persons specifically trained by **LOMBARDINI** and who work in compliance with the existing documentation.
- Variations to the functional parameters of the engine, adjustments to the fuel flow rate and rotation speed, removal of seals, demounting and refitting of parts not described in the operation and maintenance manual by unauthorized personnel shall relieve **LOMBARDINI** from all and every liability for deriving accidents or for failure to comply with the laws in merit.
- On starting, make sure that the engine is as horizontal as possible, unless the machine specifications differ.
  In the case of manual start-ups, make sure that the relative actions can take place without the risk of hitting walls or dangerous objects, also considering the movements made by the operator.
  Pull-starting with a free cord (thus excluding self-winding starting only), is not permitted even in an emergency.
- Make sure that the machine is stable to prevent the risk of overturning.
- Become familiar with how to adjust the rotation speed and stop the engine.
- Never start the engine in a closed place or where there is insufficient ventilation.
  Combustion creates carbon monoxide, an odourless and highly poisonous gas.
  Lengthy stays in places where the engine freely exhausts this gas can lead to unconsciousness and death.
- The engine must not operate in places containing inflammable materials, in explosive atmospheres, where there is dust that can easily catch fire unles specific, adequate and clearly indicated precautions have been taken and have been certified for the machine.
- To prevent fire hazards, always keep the machine at least one meter from buildings or from other machinery.
- Children and animals must be kept at a due distance from operating machines in order to prevent hazards deriving from their operation.
- Fuel is inflammable.
  The tank must only be filled when the engine is off.
  Thoroughly dry any spilt fuel and move the fuel container away along with any rags soaked in fuel or oil.
  Make sure that no soundproofing panels made of porous material are soaked in fuel or oil.
  Make sure that the ground or floor on which the machine is standing has not soaked up any fuel or oil.
- Fully tighten the tank plug each time after refuelling.
  Do not fill the tank right to the top but leave an adequate space for the fuel to expand.
- Fuel vapour is highly toxic.
  Only refuel outdoors or in a well ventilated place.
- Do not smoke or use naked flames when refuelling.
- The engine must be started in compliance with the specific instructions in the operation manual of the engine and/or machine itself.
  Do not use auxiliary starting aids that were not installed on the original machine (e.g. Startpilot').
- Before starting, remove any tools that were used to service the engine and/or machine.
  Make sure that all guards have been refitted.

- During operation, the surface of the engine can become dangerously hot.
  Avoid touching the exhaust system in particular.
- Before proceeding with any operation on the engine, stop it and allow it to cool.
  Never carry out any operation whilst the engine is running.
- The coolant fluid circuit is under pressure.
  Never carry out any inspections until the engine has cooled and even in this case, only open the radiator plug or expansion chamber with the utmost caution, wearing protective garments and goggles. If there is an electric fan, do not approach the engine whilst it is still hot as the fan could also start operating when the engine is at a standstill.
  Only clean the coolant system when the engine is at a standstill.
- When cleaning the oil-cooled air filter, make sure that the old oil is disposed of in the correct way in order to safeguard the environment.
  The spongy filtering material in oil-cooled air filters must not be soaked in oil.
  The reservoir of the separator pre-filter must not be filled with oil.
- The oil must be drained whilst the engine is hot (oil T ~ 80°C).
  Particular care is required to prevent burns.
  Do not allow the oil to come into contact with the skin.
- Pay attention to the temperature of the oil filter when the filter itself is replaced.
- Only check, top up and change the coolant fluid when the engine is off and cold.
  Take care to prevent fluids containing nitrites from being mixed with others that do not contain these substances since "Nitrosamine", dangerous for the health, can form.
  The coolant fluid is polluting and must therefore be disposed of in the correct way to safeguard the environment.
- During operations that involve access to moving parts of the engine and/or removal of rotating guards, disconnect and insulate the positive wire of the battery to prevent accidental short-circuits and to stop the starter motor from being energized.
- Only check belt tension when the engine is off.
- Only use the eyebolts installed by **LOMBARDINI** to move the engine.
  These lifting points are not suitable for the entire machine; in this case, the eyebolts installed by the manufacturer should be used.

GENERAL SAFETY DURING OPERATING PHASES

– The procedures contained in this manual have been tested and selected by the manufacturer's technical experts, and hence are to be recognised as authorised operating methods.
– A number of procedures must be carried out with the aid of equipment and tools that simplify and improve the timing of operations.
– All tools must be in good working condition so that engine components are not damaged and that operations are carried out properly and safely.
  It is important to wear the personal safety devices prescribed by work safety laws and also by the standards of this manual.
– Holes must be lined up methodically and with the aid of suitable equipment. Do not use your fingers to carry out this operation to avoid the risk of amputation.
– Some phases may require the assistance of more than one operator. If so, it is important to inform and train them regarding the type of activity they will be performing in order to prevent risks to the health and safety of all persons involved.
– Do not use flammable liquids (petrol, diesel, etc.) to degrease or wash components. Use special products.
– Use the oils and greases recommended by the manufacturer.
  Do not mix different brands or combine oils with different characteristics.
– Discontinue use of the engine if any irregularities arise, particularly in the case of unusual vibrations.
– Do not tamper with any devices to alter the level of performance guaranteed by the manufacturer.

SAFETY AND ENVIRONMENTAL IMPACT

Every organisation has a duty to implement procedures to identify, assess and monitor the influence of its own activities (products, services, etc.) on the environment.
Procedures for identifying the extent of the impact on the environment must consider the following factors:

- Liquid waste
- Waste management
- Soil contamination
- Atmospheric emissions
- Use of raw materials and natural resources
- Regulations and directives regarding environmental impact

In order to minimise the impact on the environment, the manufacturer now provides a number of indications to be followed by all persons handling the engine, for any reason, during its expected lifetime.

- All packaging components must be disposed of in accordance with the laws of the country in which disposal is taking place.
- Keep the fuel and engine control systems and the exhaust pipes in efficient working order to limit environmental and noise pollution.
- When discontinuing use of the engine, select all components according to their chemical characteristics and dispose of them separately.

TROUBLE SHOOTING

THE ENGINE MUST BE STOPPED IMMEDIATELY WHEN:

1) - The engine rpms suddenly increase and decrease;
2) - A sudden and unusual noise is heard;
3) - The colour of the exhaust fumes suddenly darkens;
4) - The oil pressure indicator light turns on while running.

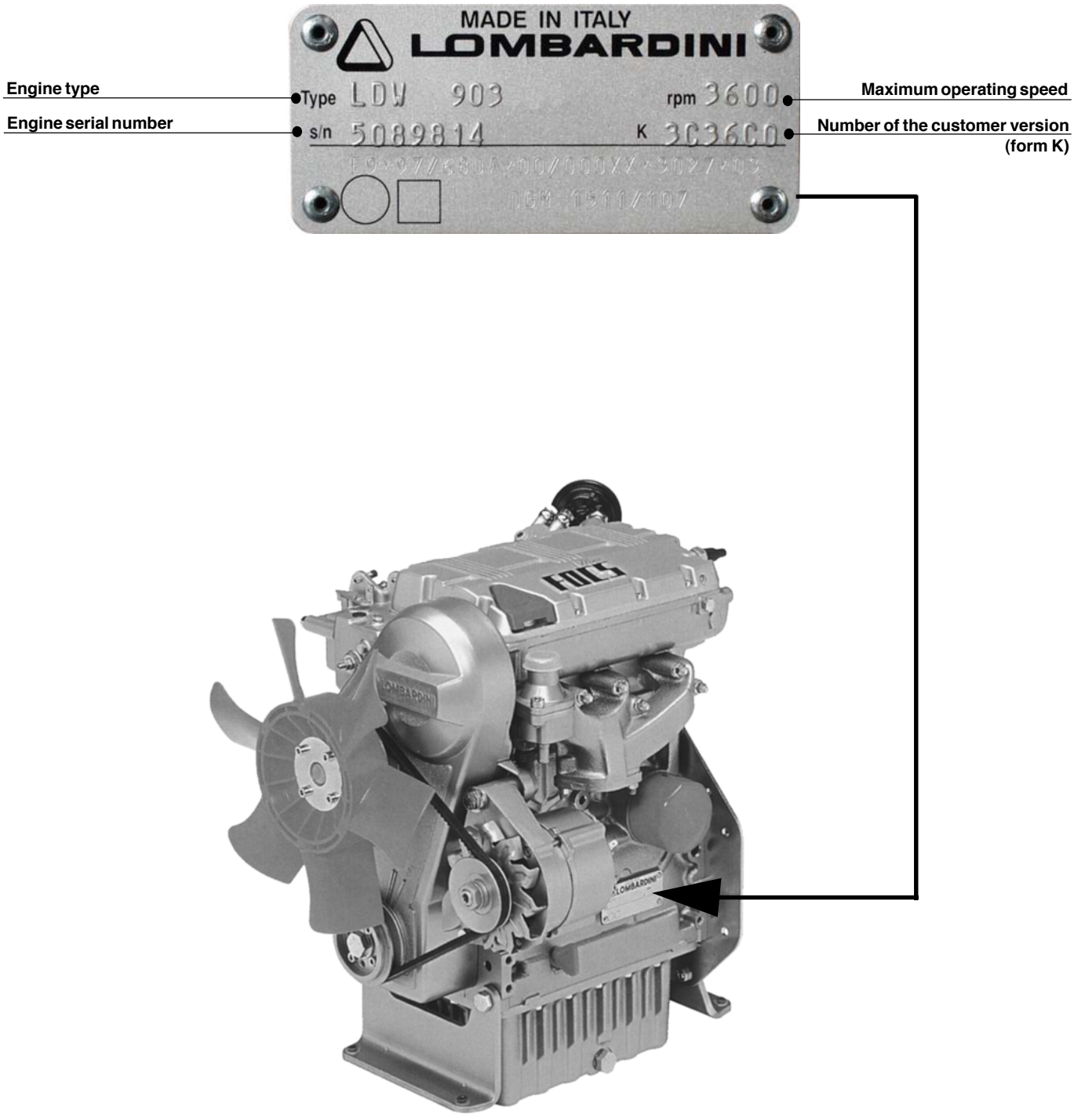
TABLE OF LIKELY ANOMALIES AND THEIR SYMPTOMS

The following table contains the possible causes of some failures which may occur during operation.
Always perform these simple checks before removing or replacing any part.

POSSIBLE CAUSE		TROUBLE												
		Engine does not start	Engine starts but stops	No acceleration	Non-uniform speed	Black smoke	White smoke	Oil preassure too low	Oil level increase	Excessive oil consumption	Oil and fuel dripping from the exhaust	Engine overheats	Inadequate performance	High noise level
FUEL CIRCUIT	Clogged fuel pipes	■	■	■	■								■	
	Clogged fuel filter	■	■	■	■								■	
	Air or water in the fuel circuit	■	■	■	■		■						■	
	Tank cap breather blocked	■	■	■	■								■	
	Faulty fuel pump	■	■	■	■				■				■	
	Lack of fuel	■	■											
ELECTRIC SYSTEM	Glow plug fuse burned	■												
	Faulty glow plug control relay	■												
	Flat battery	■												
	Unclear or mistaken cable connection	■												
	Faulty starter switch	■												
	Faulty starting motor	■												
	Faulty glow plugs	■					■							
MAINTENANCE	Clogged air filter	■	■	■	■	■				■			■	
	Prolonged operation at idle						■			■	■			
	Incomplete run-in						■			■			■	
	Overloaded engine	■	■	■		■				■		■		
SETTINGS REPAIRS	Excessive valve clearances												■	■
	Absence of valve clearances	■												
	Incorrect speed governor leverages	■			■								■	
	Speed governor spring broken or disengaged		■	■										
	Idle low		■		■	■				■	■			
	Worn out or stuck rings	■					■			■	■	■	■	
	Worn out cylinders	■					■			■	■	■	■	
	Worn out valve guides						■			■	■	■	■	
	Bad valve seal	■				■				■	■	■	■	
	Bearing shells of bearing cap - piston rod - rocker worn out							■		■		■	■	■
	E.G.R. valve blocked open					■								
	Governor leverages not running	■	■	■	■									
	Cylinder head gasket damaged	■							■	■		■	■	■
	Faulty timing system	■												■
	Supplementary starter spring broken or disengaged	■												

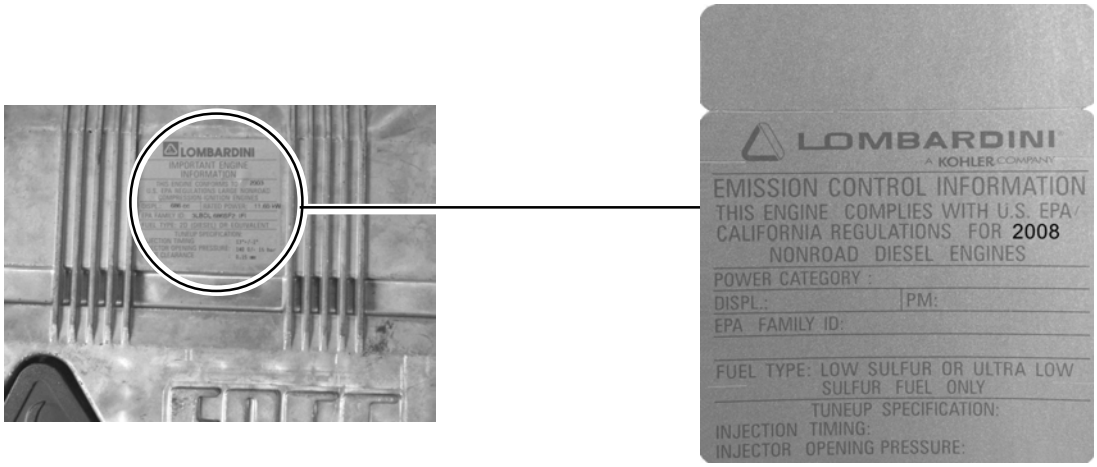
	POSSIBLE CAUSE	TROUBLE												
		Engine does not start	Engine starts but stops	No acceleration	Non-uniform speed	Black smoke	White smoke	Oil preassure too low	Oil level increase	Excessive oil consumption	Oil and fuel dripping from the exhaust	Engine overheats	Inadequate performance	High noise level
LUBRICATION CIRCUIT	High oil level				■		■			■		■	■	
	Low oil level					■		■				■	■	
	Dirty or blocked pressure regulation valve Worn oil pump					■		■				■	■	
	Air to the oil suction hose					■		■				■	■	
	Faulty manometer or pressure switch					■		■				■	■	
	Oil in sump suction hose blocked							■						
	Oil in sump drainage pipe blocked					■		■				■	■	
	Faulty spray nozzles (Turbo engines only)											■	■	
						■				■		■	■	
INJECTION	Damaged injector	■			■	■	■				■	■	■	■
	Damaged injection pump valve	■			■		■					■	■	■
	Incorrectly calibrated injector				■	■	■					■	■	
	Worn or damaged pumping element	■			■	■			■			■	■	■
	Incorrect injection pump delivery setting (delivery equalisation)			■	■	■						■	■	■
	Hardened pump/injector control rod	■	■	■	■								■	
	Cracked or broken pre-combustion chamber	■			■	■						■	■	■
	Incorrect adjustment of the injection systems (delivery equalisation advance)	■		■	■	■	■					■	■	■
COOLING CIRCUIT	Insufficient refrigerant fluid											■		
	Defective fan, radiator, or radiator cap											■		
	Defective thermostatic valve						■					■		
	Loss of refrigerant fluid from the radiator, hoses, engine crankshaft or water pump.											■		
	Inside of radiator or coolant lines obstructed.											■		
	Defective or worn water pump											■		
	Alternator fan drive belt loose or torn											■		
	Heat exchange surface of the radiator clogged											■		

MANUFACTURER AND ENGINE IDENTIFICATION



EC-directives certification references punched on the engine plate.

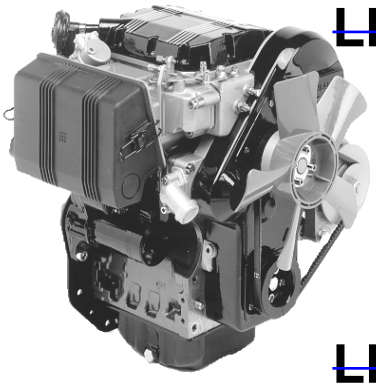
Name plate for EPA rules applied on rocker-arm cap.



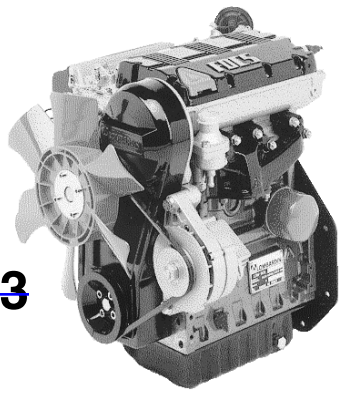
TECHINICAL SPECIFICATIONS

ENGINE TYPE			LDW 502	LDW 602	LDW 903	LDW 1204	LDW 1204/T
Cylinders		N°	2	2	3	4	4
Bore		mm	72	72	72	72	72
Stroke		mm	62	75	75	75	75
Displacements		Cm³	505	611	916	1222	1222
Compression rate			22,8:1	22,8:1	22,8:1	22,8:1	22,8:1
Rpm			3600	3600	3600	3600	3600
Maximum power	N - 80/1269/CEE ISO 1585 DIN 70020		9.8(13.4)	11.8(16.0)	17.2(23.4)	24.2(33.2)	31.0(42.0)
	NB - ISO 3046 - 1 IFN - DIN 6270		9.1(12.4)	10.3(14.0)	15.6(21.2)	22.0(30.0)	28.5(38.7)
	NA - ISO 3046 - 1 ICXN - DIN 6270		8.2(11.2)	9.2(12.5)	13.7(18.6)	19.9(27.0)	25.8(35.0)
Maximum torque *		Nm	28.7	34.5	53,5	75.1	98
		RPM	@ 2400	@ 2200	@ 2000	@ 2200	@ 2400
Maximum Torque Available @ N° 3 PTO 3600 Rpm		Nm	37/1800	37/1800	37/1800	37/1800	37/1800
Specific fuel consumption**		g/KWh	326	282	300	290	305
Oil consumption ***		Kg/h	0,007	0,007	0,012	0,017	0,019
Dry weight of engine		Kg	60	65	85	96	101
Combustion air volume at 3600 Rpm		l./1'	910	1640	1650	2200	2860 •
Cooling air volume at 3600 Rpm		m³/mm	36	43	63	88	109 ••
Axial load allowed on crankshaft (both directions)		Kg.	300	300	300	300	300
Max tilt	Instant operation (up to 1 min)	α	35°	35°	35°	35°	35°
	Intermittent operation (up to 30 min)	α	25°	25°	25°	25°	25°
	Permanent operation	α	****	****	****	****	****
Combustion sequence					1-3-2	1-3-4-2	1-3-4-2

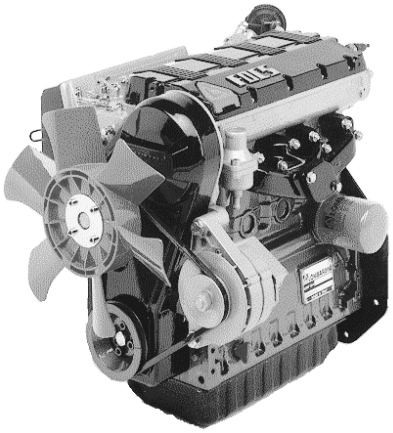
* At NB power
** Referred to NB power
*** Measured at NA power
**** Depends on application
• At 3600 Rpm
•• Measured at NB power



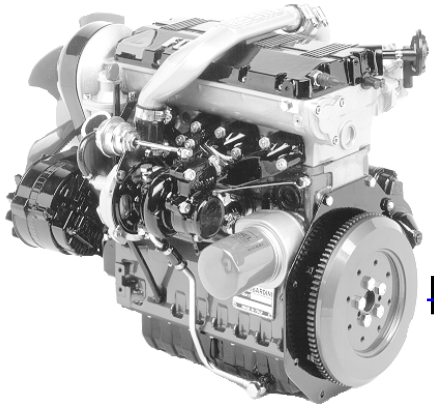
LDW 502/602



LDW 903



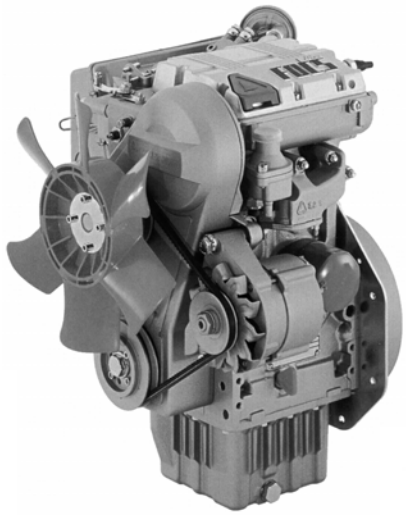
LDW 1204



LDW 1204/T

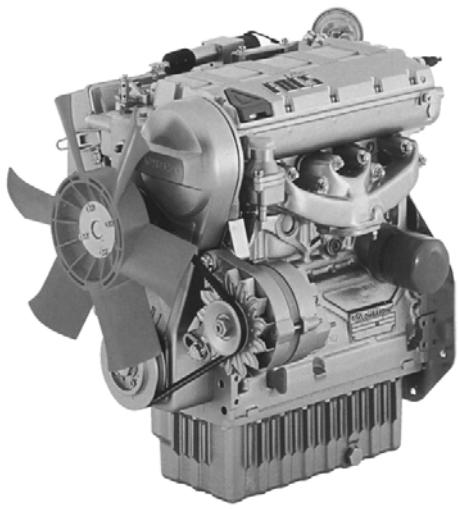
ENGINE TYPE			LDW 702	LDW 1003	LDW 1404
Cylinders		N°	2	3	4
Bore		mm	75	75	75
Stroke		mm	77.6	77.6	77.6
Displacements		Cm³	686	1028	1372
Compression rate			22,8:1	22,8:1	22,8:1
Rpm			3600	3600	3600
Maximum power	N 80/1269/CEE-ISO 1585-DIN 70020		12.5(17.0)	19.5(26.5)	26.0(35.2)
	NB ISO 3046 - 1 IFN - DIN 6270		11.7(16)	18(24.5)	24.5(33.3)
	NA ISO 3046 - 1 ICXN - DIN 6270		10.7(14.5)	16.5(22.4)	22.4(30.5)
Maximum torque *		Nm	40.5	67.0	84.0
		RPM	@ 2000	@ 2000	@ 2000
Maximum Torque Available @ N° 3 PTO 3600 Rpm		Nm	37@1800	37@1800	37@1800
Specific fuel consumption**		g/KWh	320	300	325
Oil consumption ***		Kg/h	0,009	0,013	0,019
Dry weight of engine		Kg	66	87	98
Combustion air volume at 3600 Rpm		l./1'	1240	1850	2470
Cooling air volume at 3600 Rpm		m³/min	43	63	88
Axial load allowed on crankshaft (both directions)		Kg.	300	300	300
Max tilt	Instant operation (up to 1 min)	α	35°	35°	35°
	Intermittent operation (up to 30 min)	α	25°	25°	25°
	Permanent operation	α	****	****	****

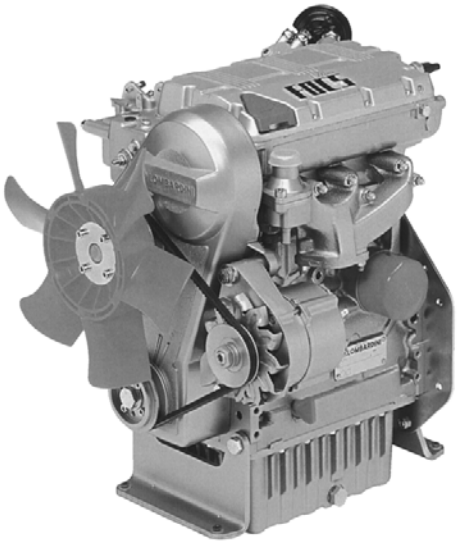
* At NB power
** Referred to NB power
*** Measured at NA power
**** Depends on application
• At 3600 Rpm
•• Measured at NB power



LDW 702

LDW 1404

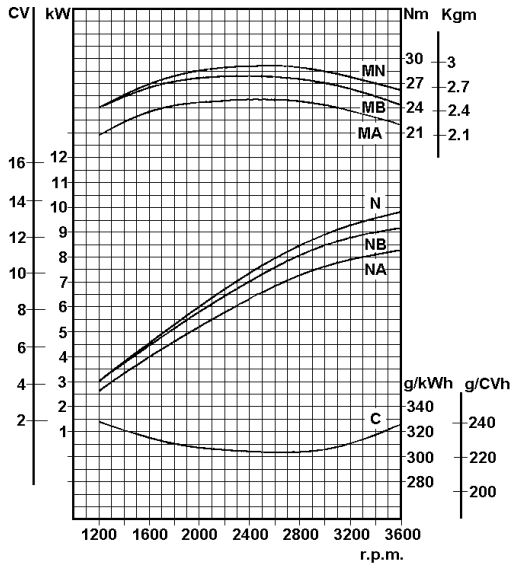




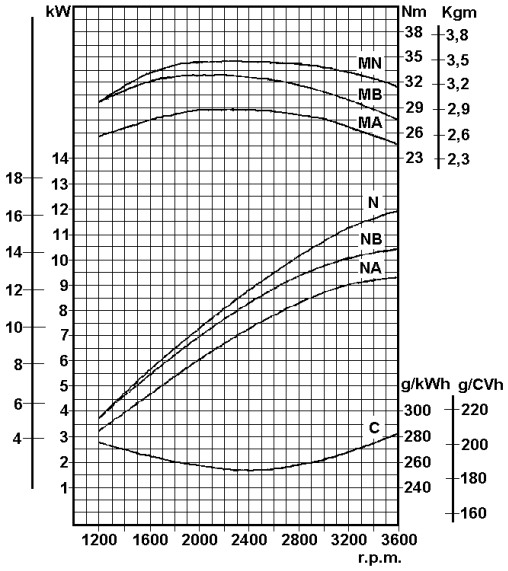
LDW 1003

PERFORMANCE DIAGRAMS

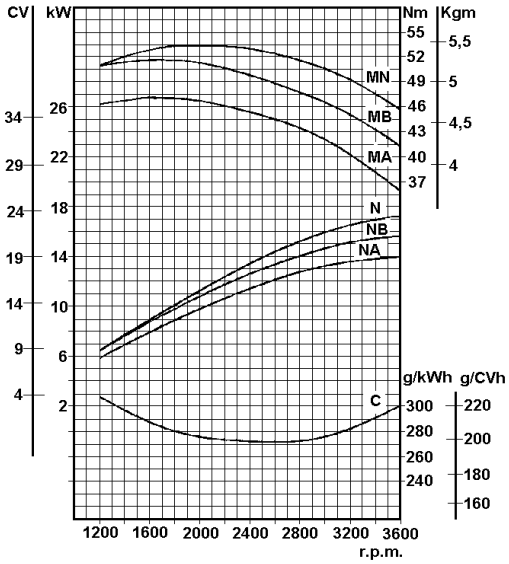
LDW 502



LDW 602



LDW 903



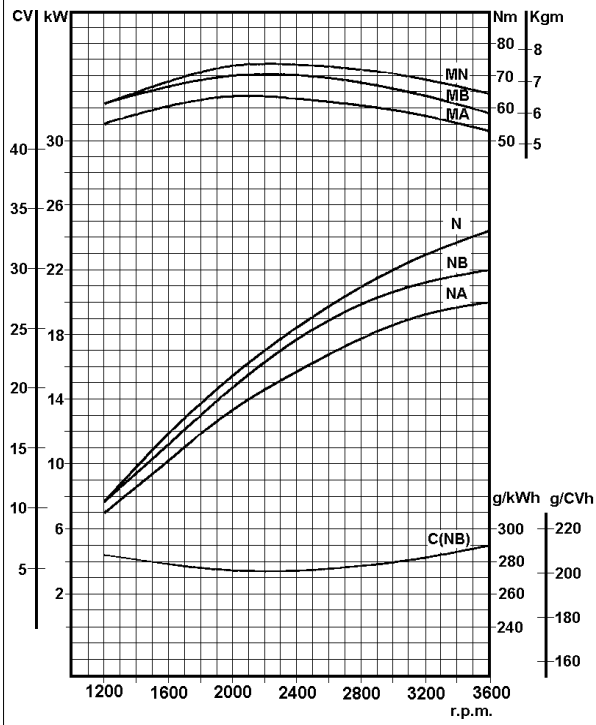
N (DIN 70020) Automotive rating, intermittent operation with variable speed and variable load.
NB (DIN 6270) Rating with no overload capability, continuous light duty operation with constant speed and variable load.
NA (DIN 6270) Continuous rating with overload capability, continuous heavy duty with constant speed and constant load.
C (NB) : Specific fuel consumption at NB power
Mt : Torque at N.
a : Range of application for continuous operation. In case of application outside this range please contact LOMBARDINI.

The above power values refer to an engine fitted with air cleaner and standard muffler, after testing and at the environmental conditions of 20°C and 1 bar. Max. power tolerance is 5%. Power decreases by approximately 1% every 100 m di altitude and by 2% every 5°C above 25°C.

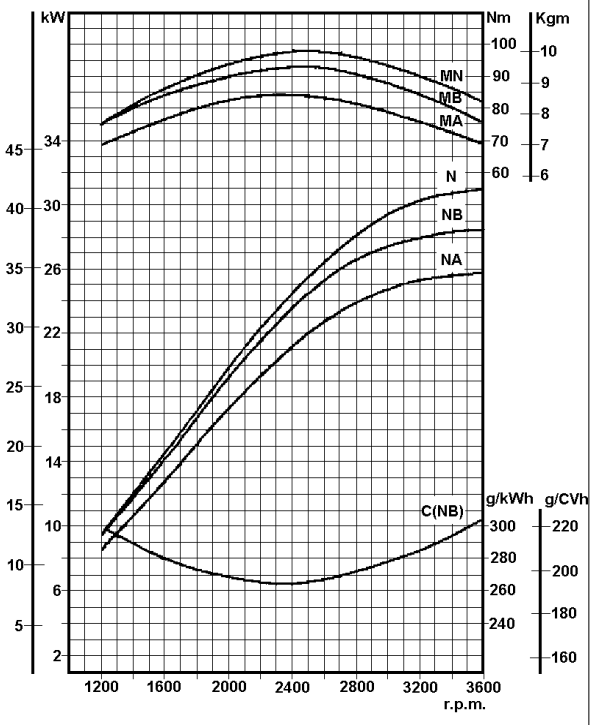
Note: Consult LOMBARDINI for power, torque curves and specific consumptions at rates differing from those given above.

Important
Non-approval by Lombardini for any modifications releases the company from any damages incurred by the engine.

LDW 1204



LDW 1204/T



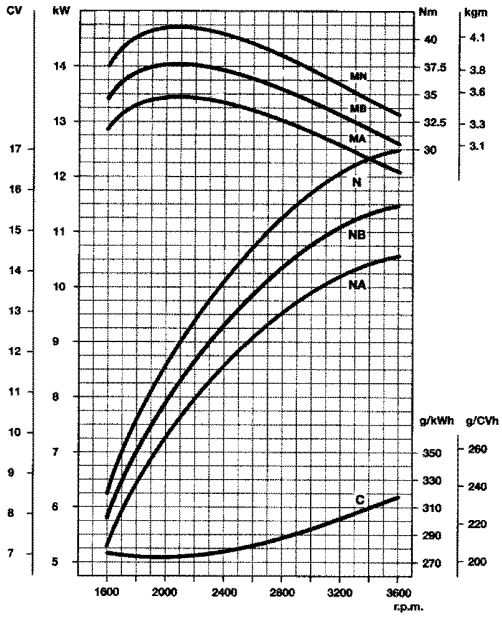
N (DIN 70020) Automotive rating, intermittent operation with variable speed and variable load.
NB (DIN 6270) Rating with no overload capability, continuous light duty operation with constant speed and variable load.
NA (DIN 6270) Continuous rating with overload capability, continuous heavy duty with constant speed and constant load.
C (NB) : Specific fuel consumption at NB power
Mt : Torque at N.
a : Range of application for continuous operation. In case of application outside this range please contact LOMBARDINI.

The above power values refer to an engine fitted with air cleaner and standard muffler, after testing and at the environmental conditions of 20°C and 1 bar. Max. power tolerance is 5%. Power decreases by approximately 1% every 100 m di altitude and by 2% every 5°C above 25°C.

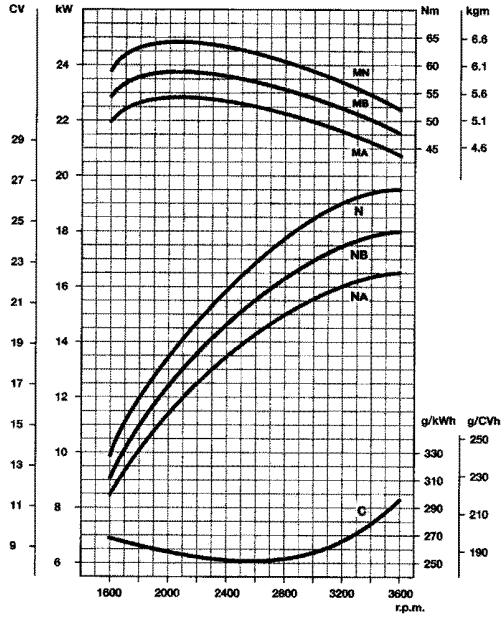
Note: Consult LOMBARDINI for power, torque curves and specific consumptions at rates differing from those given above.

Important
Non-approval by Lombardini for any modifications releases the company from any damages incurred by the engine.

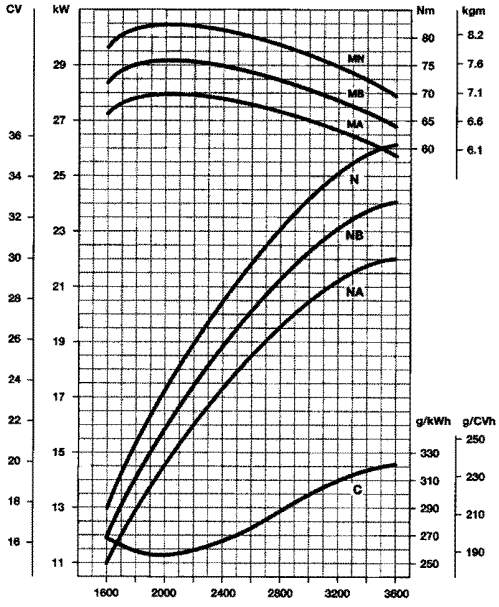
LDW 702



LDW 1003



LDW 1404



N (DIN 70020) Automotive rating, intermittent operation with variable speed and variable load.
NB (DIN 6270) Rating with no overload capability, continuous light duty operation with constant speed and variable load.
NA (DIN 6270) Continuous rating with overload capability, continuous heavy duty with constant speed and constant load.
C (NB) : Specific fuel consumption at NB power
Mt : Torque at N.
a : Range of application for continuous operation. In case of application outside this range please contact LOMBARDINI.

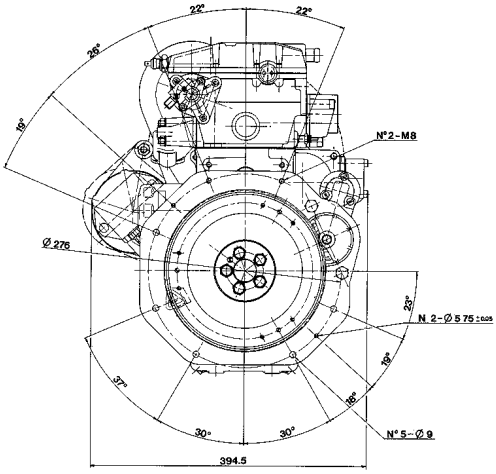
The above power values refer to an engine fitted with air cleaner and standard muffler, after testing and at the environmental conditions of 20°C and 1 bar. Max. power tolerance is 5%. Power decreases by approximately 1% every 100 m di altitude and by 2% every 5°C above 25°C.

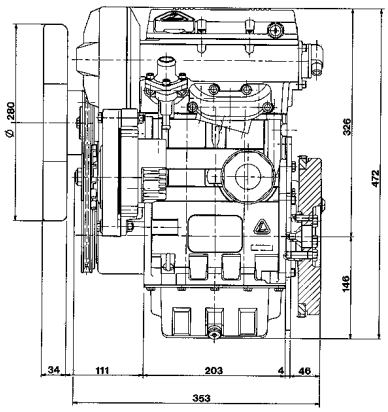
Note: Consult LOMBARDINI for power, torque curves and specific consumptions at rates differing from those given above.

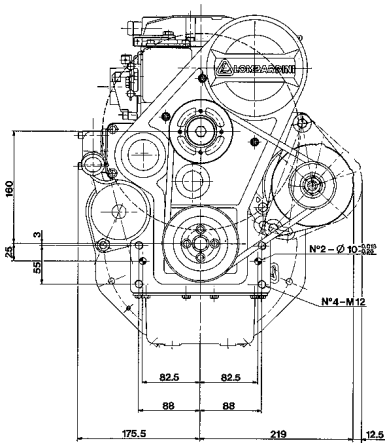
Important
Non-approval by Lombardini for any modifications releases the company from any damages incurred by the engine.

OVERALL DIMENSION

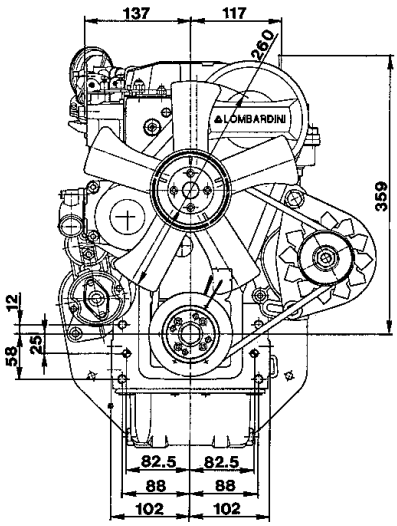
LDW 502

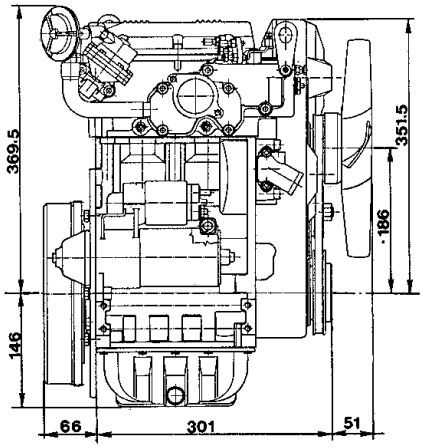


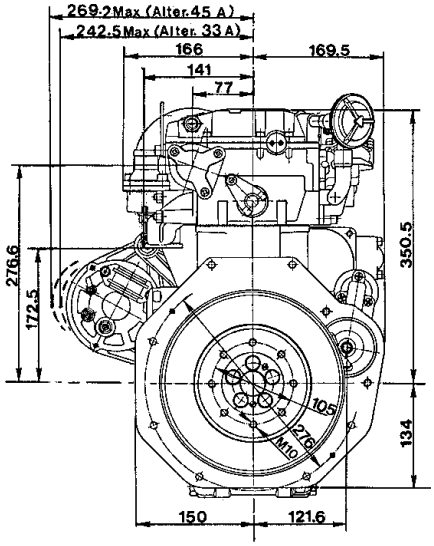




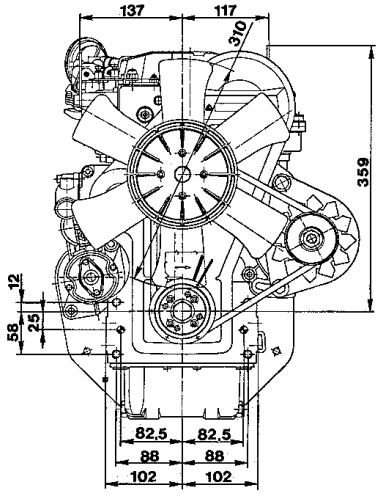
LDW 602

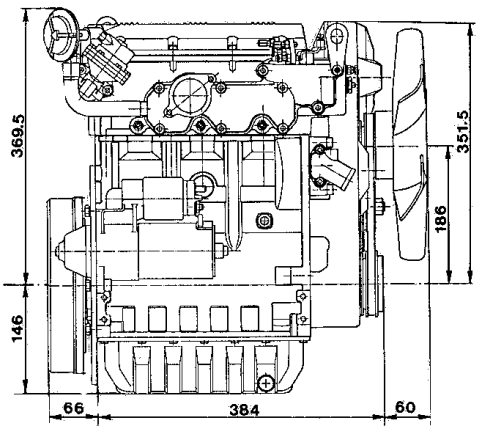


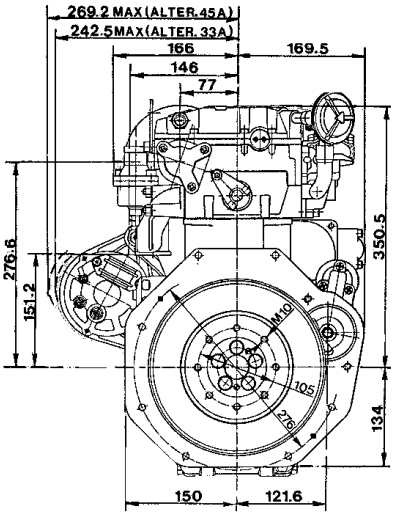




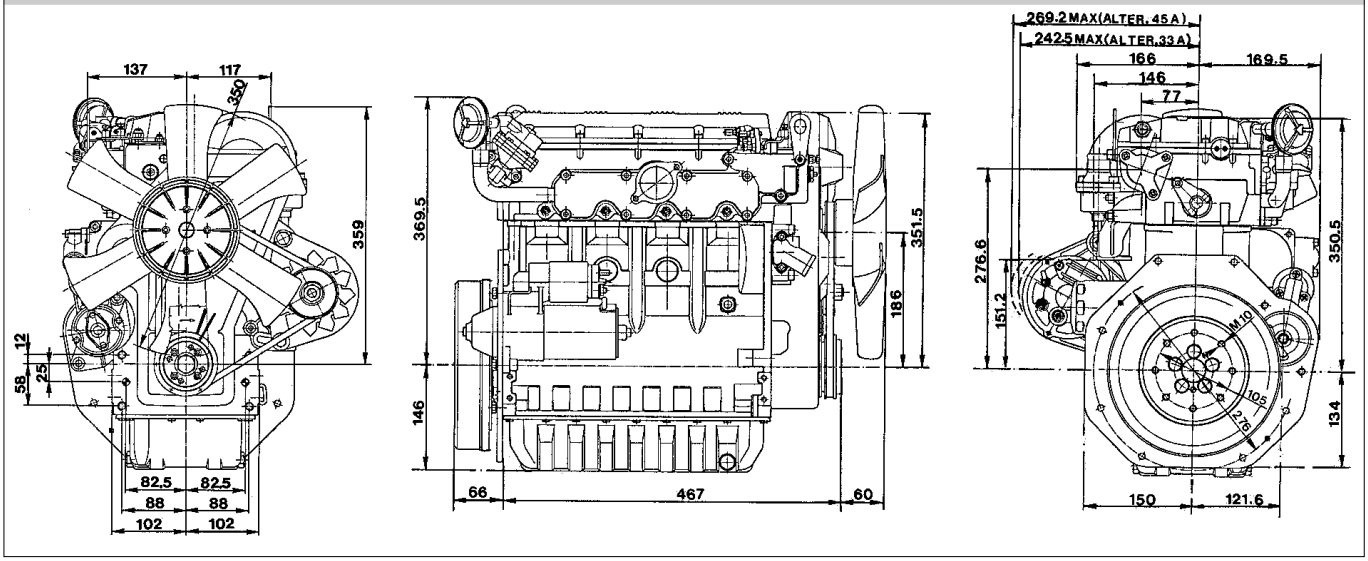
LDW 903



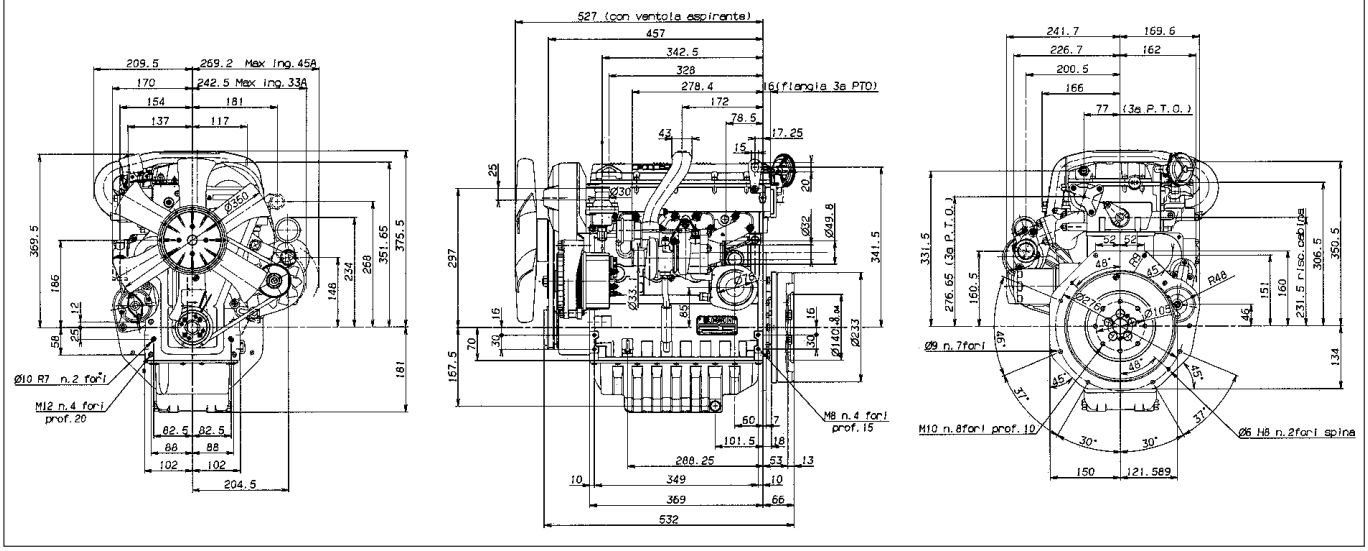




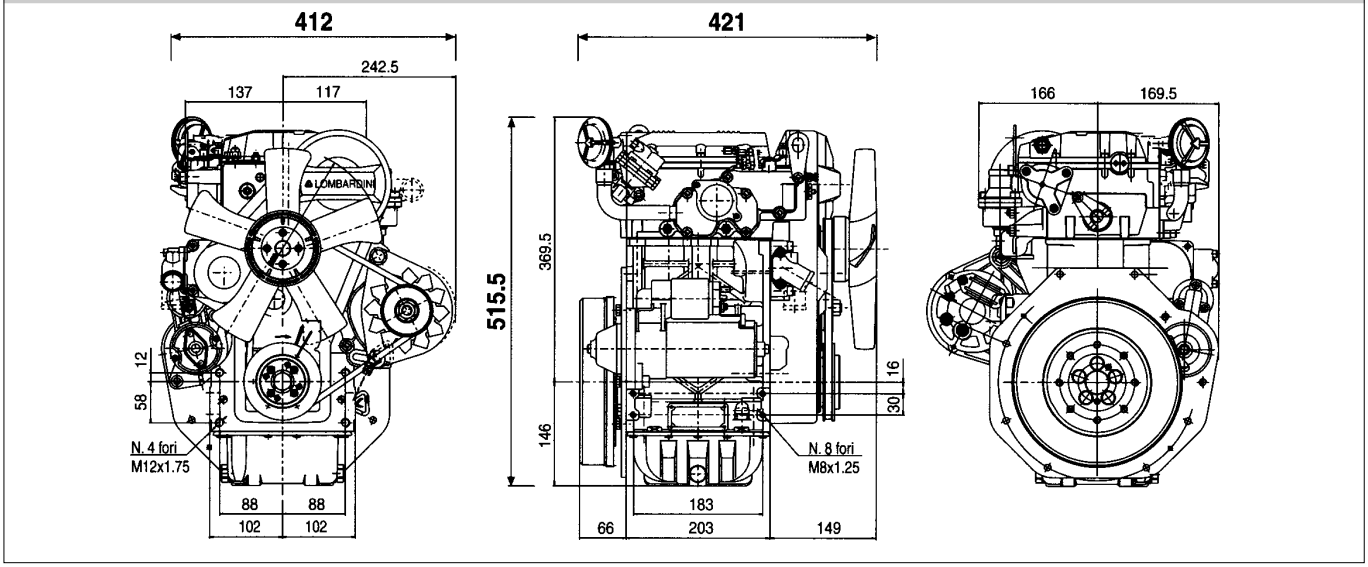
LDW 1204



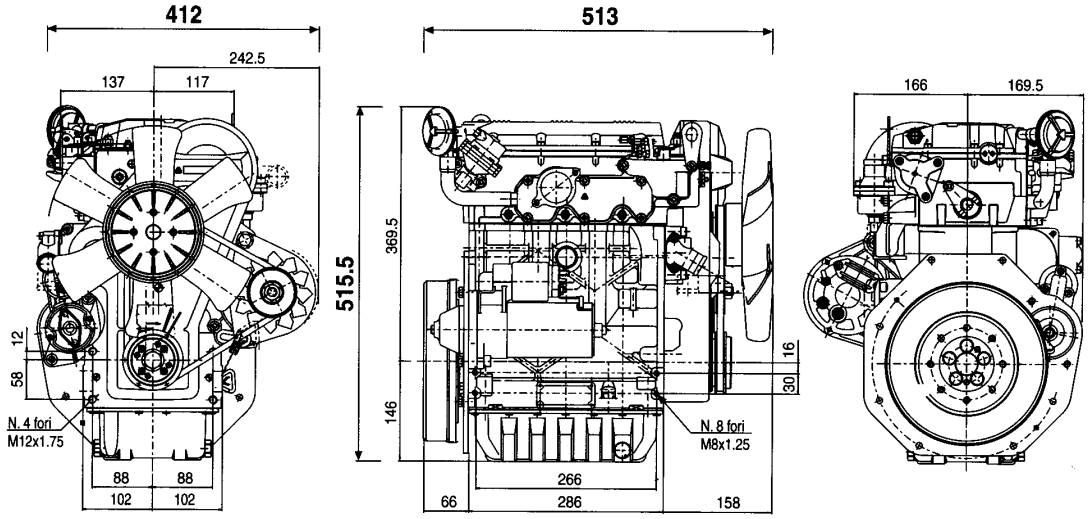
LDW 1204/T



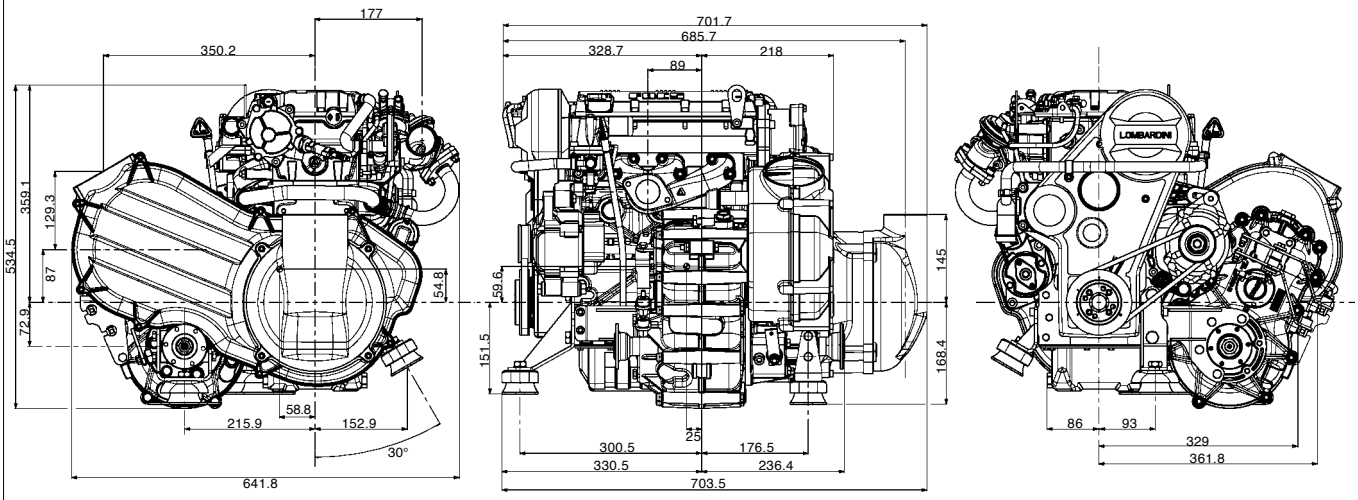
LDW 702



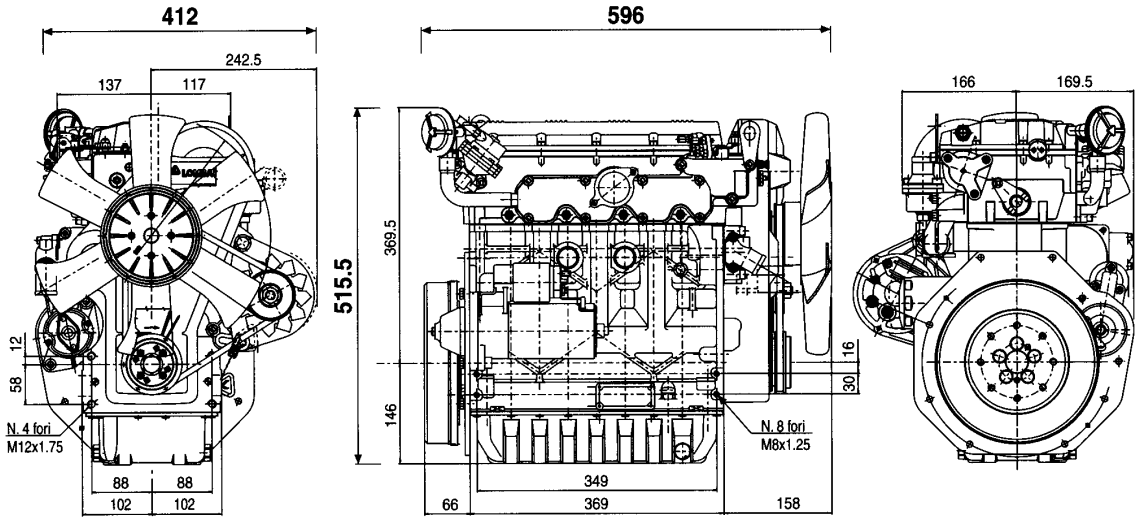
LDW 1003



LDW 1003 with EGR circuit, Gear box and CVT (Continuous Variable Transmission)



LDW 1404



ROUTINE ENGINE MAINTENANCE

Important

Failure to carry out the operations described in the table may lead to technical damage to the machine and/or system.

ORDINARY MAINTENANCE

AFTER THE FIRST 50 WORKING HOURS	Engine oil replacement.	Oil filter replacement.

ORDINARY MAINTENANCE

OPERATION DESCRIPTION		FREQUENCY x HOURS							
			10	250	300	500	1000	5000	10000
CHECK	ENGINE OIL LEVEL		■						
	COOLANT LEVEL		■						
	AIR FILTER (DRY-TYPE)	(***)	■						
	RADIATOR EXCHANGE SURFACE	(**)	■						
	VALVE CLEARANCE ADJUSTMENT	(**)				■			
	FAN / ALTERNATOR BELT STRETCH	(*)		■	▨				
	COOLING LIQUID HOSES	(*)		■	▨				
	SETTING AND INJECTORS CLEANING	(**)					■		
	FUEL PIPES		■						
	RUBBER INTAKE HOSE (AIR FILTER AND INTAKE MANIFOLD)			■	▨				
	INTERIOR RADIATOR CLEANING						■		
	ALTERNATOR AND STARTING MOTOR							■	
REPLACEMENT	ENGINE OIL	(*)		■	▨				
	OIL FILTER	(*)		■	▨				
	FUEL FILTER	(*)		■	▨				
	ALTERNATOR BELT	(**)				■			
	COOLANT	(**)					■		
	FILTER ELEMENT PANEL AIR FILTER	(***)							
	FUEL PIPES	(**)					■		
	COOLING LIQUID HOSES	(**)					■		
	RUBBER INTAKE HOSE (AIR FILTER AND INTAKE MANIFOLD)	(**) (**)					■		
	TIMING BELT	(°)	EVERY 4000 HOURS						
	DRY AIR CLEANER EXTERNAL CARTRIDGE	(***)	AFTER 6 CHECKS WITH CLEANING						
	DRY AIR CLEANER INTERNAL CARTRIDGE	(***)	AFTER 3 CHECKS WITH CLEANING						
OVERHAUL	PARTIAL							■	
	TOTAL								■

250 **STANDARD OIL SUMP**

300 **ENHANCED OIL SUMP**

(*) - **In case of low use: every year.**

(**) - **In case of low use: every 2 years.**

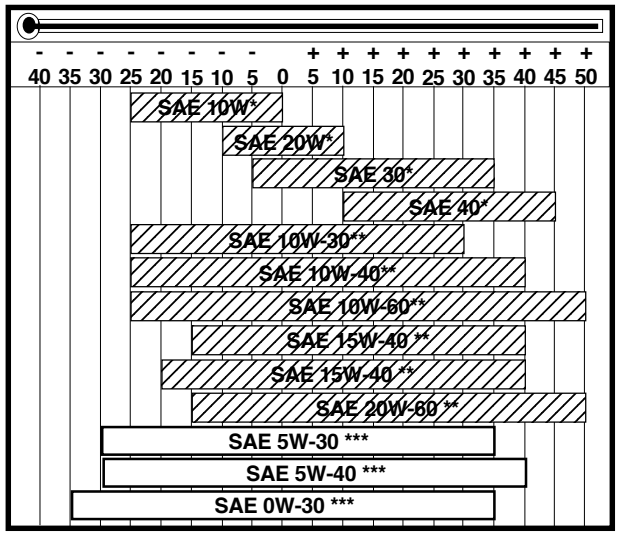
(***) - **The period of time that must elapse before cleaning or replacing the filter element depends on the environment in which the engine operates. The air filter must be cleaned and replaced more frequently In very dusty conditions.**

(°) - **Once removed, the timing belt should be replaced even if its scheduled motion period is not over.**

LUBRICANT

SAE Classification

In the SAE classification, oils differ on the basis of their viscosity, and no other qualitative characteristic is taken into account.
The first number refers to the viscosity when the engine is cold (symbol W = winter), while the second considers viscosity with the engine at régime.
The criteria for choosing must consider, during winter, the lowest outside temperature to which the engine will be subject and the highest functioning temperature during summer.
Single-degree oils are normally used when the running temperature varies scarcely.
Multi-degree oil is less sensitive to temperature changes.



SAE- Grade

** Mineral base*
*** Semi-synthetic base*
**** Synthetic base*

International specifications

They define testing performances and procedures that the lubricants need to successfully respond to in several engine testing and laboratory analysis so as to be considered qualified and in conformity to the regulations set for each lubrication kind.
A.P.I : (American Petroleum Institute)
MIL : Engine oil U.S. military specifications released for logistic reasons
ACEA : European Automobile Manufacturers Association
Tables shown on this page are of useful reference when buying a kind of oil.
Codes are usually printed-out on the oil container and the understanding of their meaning is useful for comparing different brands and choosing the kind with the right characteristics.
Usually a specification showing a following letter or number is preferable to one with a preceding letter or number.
An SF oil, for instance, is more performing than a SE oil but less performing than a SG one.

ACEA Regualtions - ACEA Sequences

PETROL

A1 =Low-viscosity, for frictions reduction
A2 =Standard
A3 =High performances

LIGHT DUTY DIESEL ENGINES

B1 =Low-viscosity, for frictions reduction
B2 =Standard
B3 =High performances (indirect injection)
B4 =High quality (direct injection)

HEAVY DUTY DIESEL ENGINES

~~E1 =OBSOLETE~~

E2 =Standard
E3 =Heavy conditions (Euro 1 - Euro 2 engines)
E4 =Heavy conditions (Euro 1 - Euro 2 - Euro 3 engines)
E5 =High performances in heavy conditions (Euro 1 - Euro 2 - Euro 3 engines)

API / MIL Sequences

	DIESEL										PETROL									
API	CH-4	CG-4	CF-4	CF-2	CF	CE	CD	CC	CB	CA	SA	SB	SC	SD	SE	SF	SG	SH	SJ	SL
MIL						L - 2104 D / E					L - 46152 B / C / D / E									

CURRENT ~~OBSOLETE~~

PRESCRIBED LUBRICANT

AGIP SINT 2000 5W40	specifications	**API SJ/CF ACEA A3-96 B3-96 MIL - L-46152 D/E**

In the countries where AGIP products are not available, use oil API CF/SH for Diesel engines or oil corresponding to the military specification MIL-L-2104 C/46152 D.

CHD ENGINES OIL CAPACITY			LDW 502	LDW 602 LDW 702	LDW 903 LDW 1003	LDW 1204	LDW 1404	LDW 1204/T
OIL VOLUME AT MAX LEVEL (OIL FILTER INCLUDED)	Sheet STD oil sump.	Litres	1,5	1,6	2,4	3,2	3,2	4,3
	ENHANCED aluminium oil sump.		2,5	2,5	3,8	5,2	5,2	-
OIL VOLUME AT MAX LEVEL (WITHOUT OIL FILTER)	Sheet STD oil sump.	Litres	1,4	1,5	2,3	3,0	3,0	4,1
	ENHANCED aluminium oil sump.		2,4	2,4	3,7	5,0	5,1	-

*** With dynamic balancer**

Important

If you are using oil of a quality lower than the prescribed one then you will have to replace it every 125 hours for the standard sump and every 150 hours for the enhanced sump.

Danger – Attention

- **The engine may be damaged if operated with insufficient lube oil. It is also dangerous to supply too much lube oil to the engine because a sudden increase in engine rpm could be caused by its combustion.**
- **Use proper lube oil preserve your engine. Good quality or poor quality of the lubricating oil has an affect on engine performance and life.**
- **If inferior oil is used, or if your engine oil is not changed regularly, the risk of piston seizure, piston ring sticking, and accelerated wear of the cylinder liner, bearing and other moving components increases significantly.**
- **Always use oil with the right viscosity for the ambient temperature in which your engine is being operated.**

Danger – Attention

- **The used engine oil can cause skin-cancer if kept frequently in contact for prolonged periods.**
- **If contact with oil cannot be avoided, wash carefully your hands with water and soap as soon as possible.**
- **Do not disperse the oil in the ambient, as it has a high pollution power.**

COOLANT

Danger – Attention

- **The fluid coolant circuit is pressurized. Inspections must only be made when the engine has cooled and even in this case, the radiator or expansion chamber plug must be unscrewed with the utmost caution.**
- **If an electric fan is installed, do not approach a hot engine since the fan itself could start up even when the engine is at a standstill.**
- **Coolant fluid is polluting, it must therefore be disposed of in the correct way. Do not litter.**

The anti-freeze protection liquid (AGIP ANTIFREEZE SPEZIAL) must be used mixed with water, preferably decalcified. The freezing point of the cooling mixture depends on the product concentration in water, it is therefore recommended to use a 50% diluted mixture which guarantees a certain degree of optimal protection. As well as lowering the freezing point, the permanent liquid also raises the boiling point.

Coolant refueling

ENGINE TYPE	LDW 502	LDW 602-702	LDW 903-1003	LDW 1204-1404	LDW 1204/T
CAPACITY (Litres) Without radiator	0,75	0,90	1,30	1,75	1,90

For information concerning the capacity of Lombardini radiators, please contact Lombardini directly.
The total volume for refilling the cooling liquid varies according to the type of engine and radiator.

FUEL SPECIFICATIONS

To achieve optimum performance of the engine, use good quality fuel with certain characteristics:

Cetane number (minimum 51): indicates the ignition quality. A fuel with a low cetane number may cause problems when starting from cold and have a negative effect on combustion.
Viscosity (2.0/4.5 centistokes at 40°C): this is the resistance to flow and performance may decline if not within the limits.
Density (0.835/0.855 Kg/litre): a low density reduces the power of the engine, and density that is too high increases performance and opacity of the exhaust
Distillation (85% at 350°): this is an indication of the mixture of different hydrocarbons in the fuel. A high ratio of light hydrocarbons may have a negative effect on combustion.
Sulphur (maximum 0.05% of the weight): high sulphur content may cause engine wear. In those countries where diesel has a high sulphur content, it is advisable to lubricate the engine with a high alkaline oil or alternatively to replace the lubricating oil recommended by the manufacturer more frequently.

PRESCRIBED LUBRICANT	
Fuel with low sulphur content	API CF4 - CG4
Fuel with high sulphur content	API CF - CD - CE

The countries in which diesel normally has a low sulphur content are: Europe, North America and Australia.

FUELS FOR LOW TEMPERATURES
It is possible to run the engine at temperatures below 0°C using special winter fuels. These fuels reduce the formation of paraffin in diesel at low temperatures. If paraffin forms in the diesel, the fuel filter becomes blocked interrupting the flow of fuel.

Fuel can be:
- **Summer up to 0°C**
- **Winter up to -10°C**
- **Alpine up to -20°C**
- **Arctic up to -30°C**

For all fuel types, the cetane number cannot be lower than 51.

AVIATION KEROSENE AND RME FUELS (BIOFUELS)
The only Aviatin fuels that may be used in this engine are: JP5, JP4, JP8 and JET-A if 5% oil is added.
For more information on Aviation fuels and Biofuels (RME, RSME) please contact the Lombardini applications department.

RECOMMENDATIONS FOR DISASSEMBLING AND ASSEMBLING

Important
To locate specific topics, the reader should refer to the index.

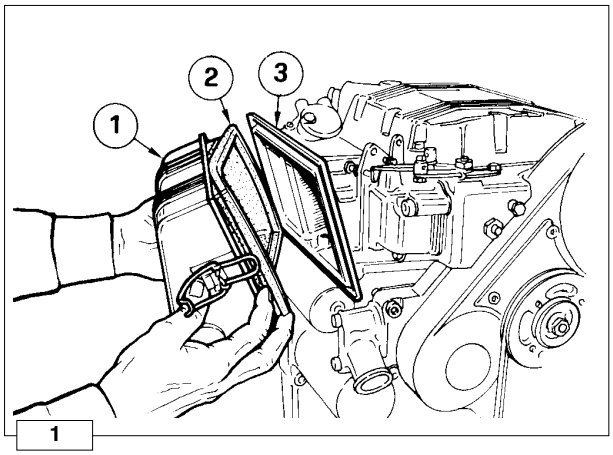
- Besides disassembly and reassembly operations this chapter also includes checking and setting specifications, dimensions, repair and operating instructions.
- Always use original LOMBARDINI spare parts for proper repair operations.
- The operator must wash, clean and dry components and assemblies before installing them.
- The operator must make sure that the contact surfaces are intact, lubricate the coupling parts and protect those that are prone to oxidation.
- Before any intervention, the operator should lay out all equipment and tools in such a way as to enable him to carry out operations correctly and safely.
- For safety and convenience, you are advised to place the engine on a special rotating stand for engine overhauls.
- Before proceeding with operations, make sure that appropriate safety conditions are in place, in order to safeguard the operator and any persons involved.
- In order to fix assemblies and/or components securely, the operator must tighten the fastening parts in a criss-cross or alternating pattern.
- Assemblies and/or components with a specific tightening torque must initially be fastened at a level lower than the assigned value, and then subsequently tightened to the final torque.

RECOMMENDATIONS FOR OVERHAULS AND TUNING

Important
To locate specific topics, the reader should refer to the index.

- Before any intervention, the operator should lay out all equipment and tools in such a way as to enable him to carry out operations correctly and safely.
- The operator must comply with the specific measures described in order to avoid errors that might cause damage to the engine.
- Before carrying out any operation, clean the assemblies and/or components thoroughly and eliminate any deposits or residual material.
- Wash the components with special detergent and do not use steam or hot water.
- Do not use flammable products (petrol, diesel, etc.) to degrease or wash components. Use special products.
- Dry all washed surfaces and components thoroughly with a jet of air or special cloths before reassembling them.
- Apply a layer of lubricant over all surfaces to protect them against oxidation.
- Check all components for intactness, wear and tear, seizure, cracks and/or faults to be sure that the engine is in good working condition.
- Some mechanical parts must be replaced *en bloc*, together with their coupled parts (e.g. valve guide/valve etc.) as specified in the spare parts catalogue.

Danger - Attention
During repair operations, when using compressed air, wear eye protection.



1

Dry type air filter

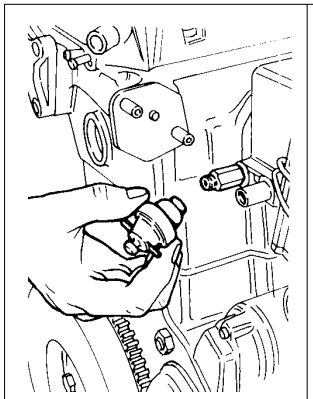
Danger - Attention
Never clean the filtering element with highly flammable solvents Danger of explosion!

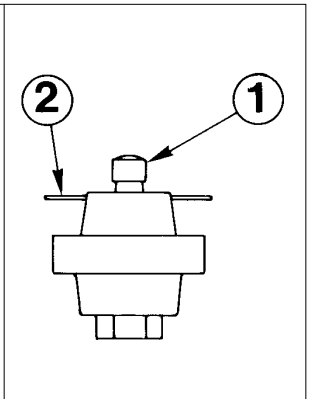
Important
Blow compressed air crossways over the external part and inside the cartridge at a pressure no greater than 5 atm or if necessary knock the front of the cartridge repeatedly against a flat surface.

Components: **1** Cover
2 Filter element
3 Support

Air filter specifications:
Filtration level = 13÷14 μm.
Filtration area = 4470 cm² per LDW 502, 602, 903, 702, 1003
Filtration area = 7150 cm² per LDW 1204,1404

➲ See page 24 for periodic maintenance details.


2



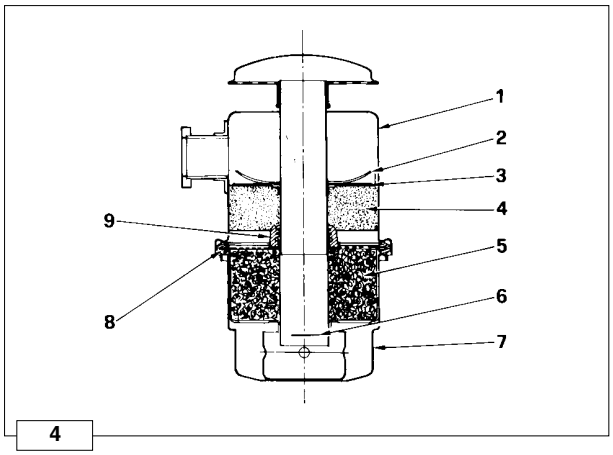
3

Air restriction switch

Components:

1 Reset buttione
2 .25" Tab connection

Note: The indicator is calibrated at 600÷650 mm of water column for LDW 502, 602, 702, 903, 1003, 1204, 1404; and 370÷420 mm of water column for LDW 1204/T.



4

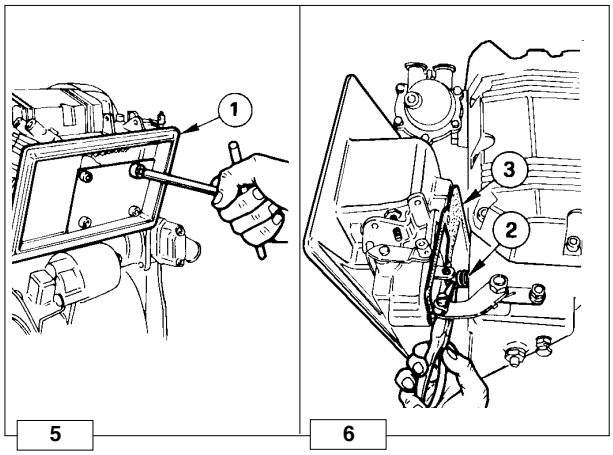
Oil bath air cleaner (on request)

Important
Check the sealing rings regularly.
Replace the sealing rings if hardening or damage is noted

1 Upper Housing
2 Diaphragm Seat
3 Diaphragm
4 Polyurethane upper element
5 Metal wool lower eleme
6 Oil level reference mark
7 Reservoir bowl
8 Outer seal ring
9 Inner seal ring

Note: Carefully clean the reservoir bowl and both elements with clean diesel fuel. Blow the lower element dry with compressed air. Dry the upper element by squeezing out excess diesel fuel, then drying with suitable cloths.
Fill the reservoir with clean engine oil to the reference mark.

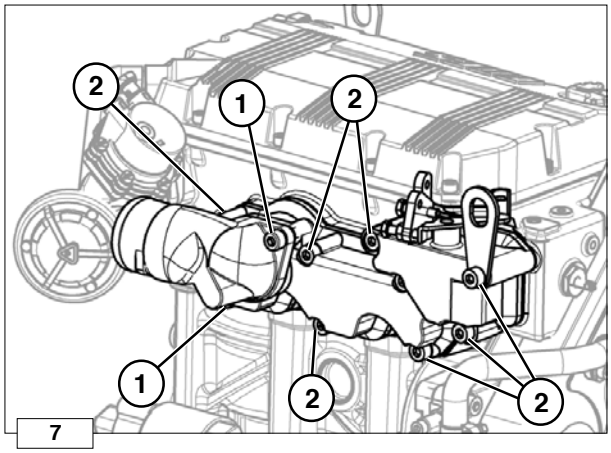
➲ See page 24 for periodic maintenance and replacement details.



5 6

Air filter support

The support for air filter 1 incorporates the intake manifold and the accelerator control box.
Remove all bolts that secure the air filter support **1** to the cylinder head. Carefully pull the air filter support from the cylinder head. Using suitable pliers, release the governor spring **2** from the air filter support assembly.
Replace the gasket **3**.

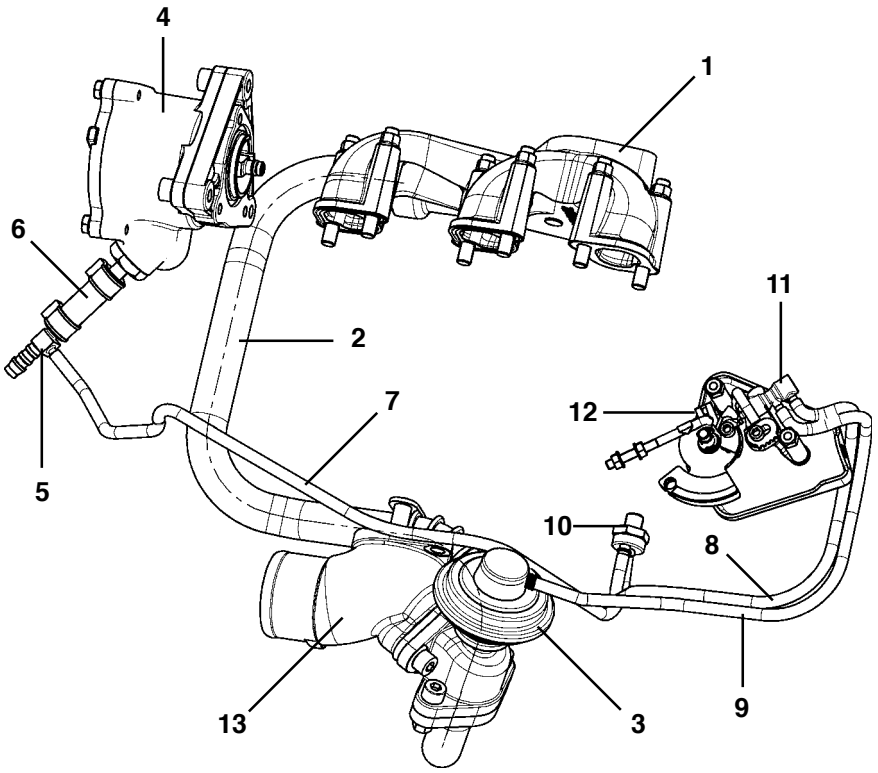


7

Intake manifold – Remote air filter

- Unscrew the the fastening screws (**1**) that fix the intake duct to the intake manifold unit.
- Unscrew the two fastening screws (**2**) of the intake manifold from the engine crankcase.
- Lift the intake manifold and disengage the hook of the min/max cylinder from the same manifold (fig. 212).

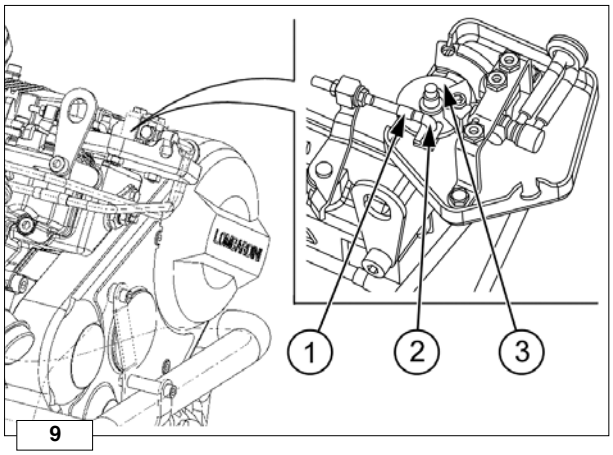
E.G.R. Circuit



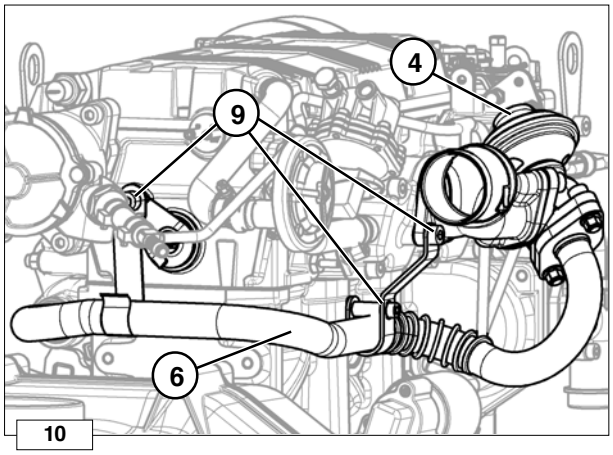
8

Components:

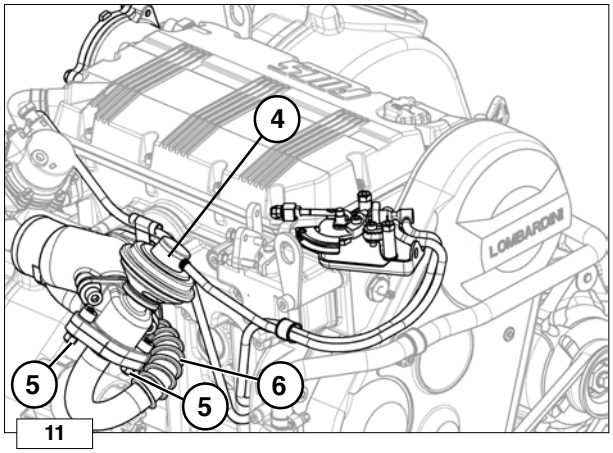
1. Exhaust manifold
2. E.G.R. Pipe
3. E.G.R. Valve
4. Vacuum pump
5. Three way union
6. Vacuum pump pipe
7. Thermovalve – vacuum pump connection pipe
8. Vacuum valve – thermovalve connection pipe
9. Vacuum valve - E.G.R. connection pipe
10. Thermovalve
11. Vacuum valve
12. ON-OFF sensor control cam
13. Intake duct



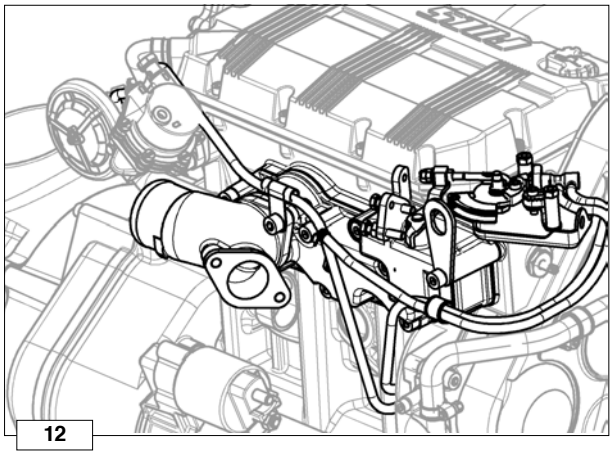
9



10



11


12

E.G.R. Circuit

Operation

The main function of the E.G.R. (Exhaust Gas Recirculation) system is the reduction in emission of NOx (nitrogen oxides), gases harmful to people and the environment, via lowering the combustion temperature.
The system takes a certain quantity of exhaust gas from the exhaust manifold **1** (fig. 8) via the E.G.R. pipe (**2**) to the E.G.R. valve **3**.
This valve is opened by the vacuum (created in pipes **6**, **7**, **8** and **9** by vacuum pump **4**; fig. 8) only when:

a) thermovalve **10** placed in contact with the engine refrigerant fluid reaches a temperature of 40 °C;

b) the on-off sensor control cam **12** opens the vacuum valve 11 at a determined accelerator position.

Once the E.G.R. valve is opened, the exhaust gas enters the intake manifold **13** via the intake flange.
The same logic controls the closure of the E.G.R. valve.

Disassembly:

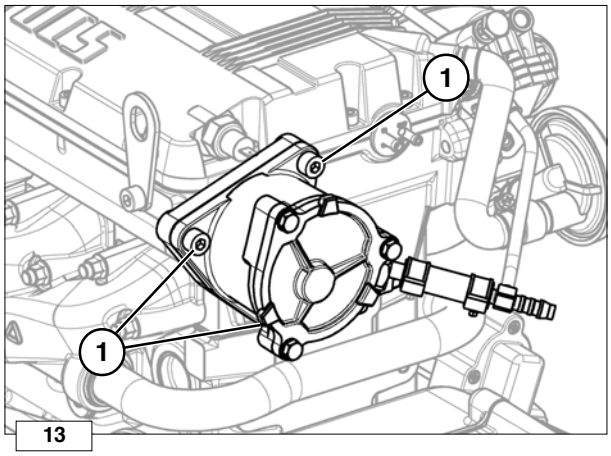
- Disengage the control rod catch (**1**) with a screwdriver from the accelerator control rod (**2**) (fig. 9).
- Disconnect the accelerator control rod (**2**) from the accelerator control lever (**3**) (fig. 9).
- Disconnect the thermovalve – vacuum pump connection pipes (**7**, fig. 8) and vacuum valve – thermovalve connection pipe (**8**, fig. 8) from the thermovalve.
- Unscrew the two fastening screws (**5**) that fix the E.G.R. pipe (**6**) to the E.G.R. valve (**4**) (figures 10, 11 and 12).
- Remove the intake manifold. See "Intake manifold – Remote air filter" on page 30 (Figure 7).
- Unscrew the fastening screw of the E.G.R. pipe support bracket (**9** fig. 10) from the engine crankcase and disengage the E.G.R. pipe from the exhaust manifold.

Reassembly:

When reassembling pay attention to the repositioning of the gaskets and to the precise connection of the pipes (**6**, **7**, **8**, **9**, fig. 8).
These pipes should be carefully fitted on the appropriate connections.

❍ Tighten the screws to specified torque, see "Table of tightening torques for the main components" on page 100.

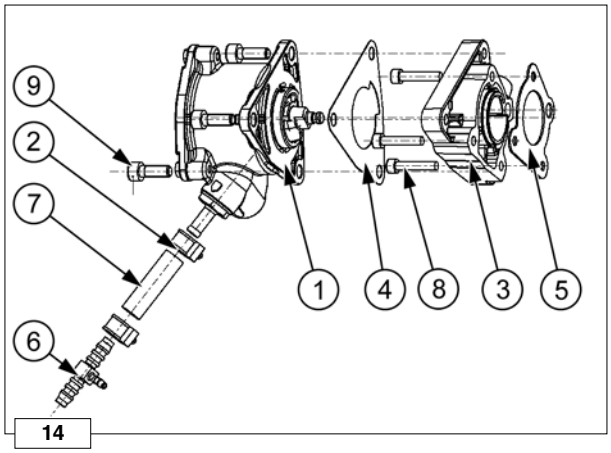
➲ For the calibration of the E.G.R. system see "E.G.R. calibration" on page 97.



13

Vacuum pump and vacuum pump flange

Unscrew the three fastening screws 1 that fix the vacuum pump to the flange and remove the vacuum pump.
Unscrew the fastening screws that fix the flange to the engine crankcase and remove it.

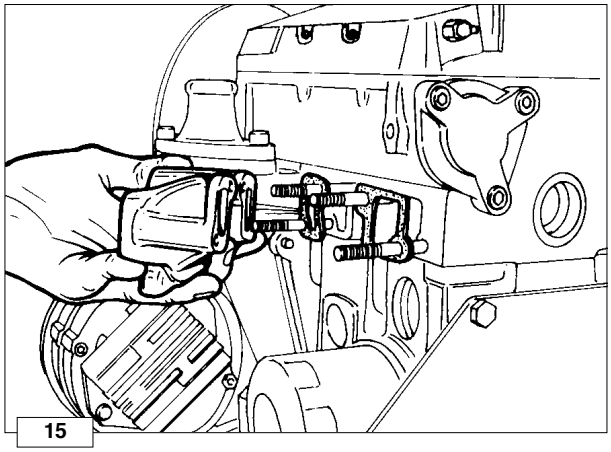


14

Components:

1. Vacuum pump
2. Clic clamp 86-50
3. Vacuum pump flange
4. Vacuum pump gasket-
5. Vacuum pump flange gasket
6. Three-way union for vacuum pump
7. Vacuum pump pipe
8. Screw
9. Screw

❍ When reassembling, tighten the screws (**8**) that fix the flange to the cylinder head to the specified torque of 10 Nm, and the screws (**9**) that fix the vacuum pump to the flange at the specified torque of 15 Nm.

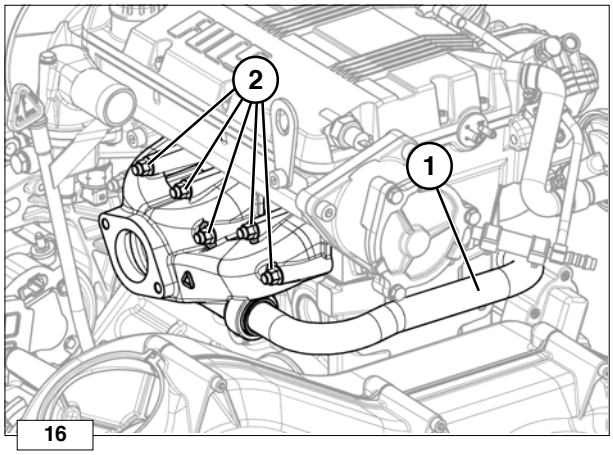

15

Exhaust maniflod

Danger - Attention
Let the exhaust manifold cool before dismounting to avoid scalds and burns.

When you dismount the exhaust manifold check that the inside is properly clean and free from cracks or breaks.
Replace gaskets every time you remove the manifold.

❍ Tighten nuts at 25 Nm.



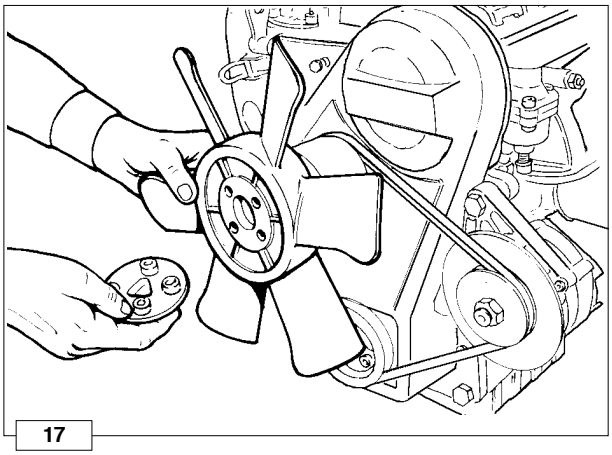
16

Exhaust manifold - engines with EGR

Remove the E.G.R. pipe (**1**).
Unscrew the locking nuts (**2**) and remove the exhaust manifold and the seal.

Note: When reassembling the exhaust manifold, check that the inside is properly clean and free from cracks or breaks.
Note: Replace the gasket each time the manifold is reassembled.

❍ Tighten the nuts at the prescribed torque of 25 Nm.

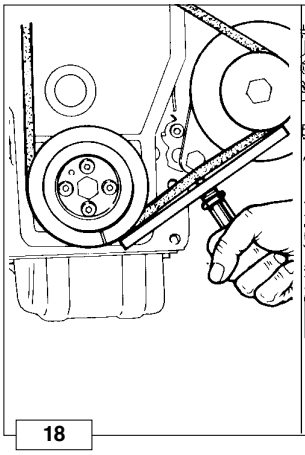

17

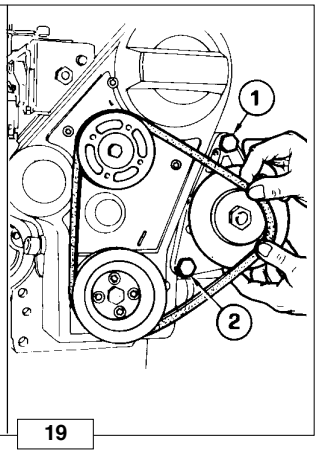
Cooling fan

Danger - Attention
Carry out the cooling fan disassembly, only after isolating the positive battery cable to prevent accidental short-circuiting and, consequently, the activation of the starter motor.

Carefully clean and check all blades. Replace the fan even if there is only a single damaged blade.

➲ See pages 16÷17 for cooling air flow volume.


18



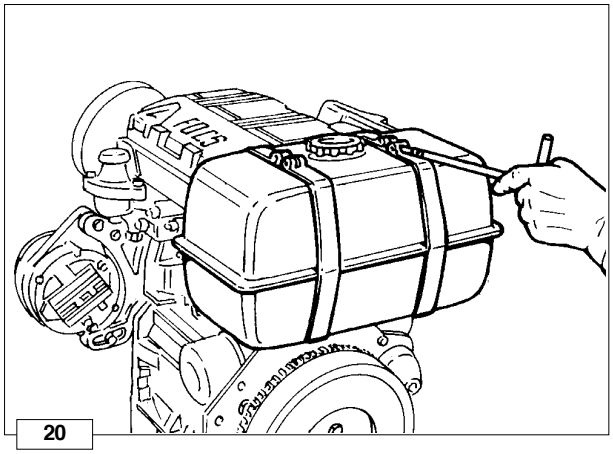
19

Alternator/Cooling fan belt drive

Danger - Attention
Check the belt tension only with the engine off.

Tension adjustment.
Loosen screws **1** and **2**.
Adjust the belt tension so that a 100N force at the midpoint of the belt center (as shown) results in a 10-15mm deflection.

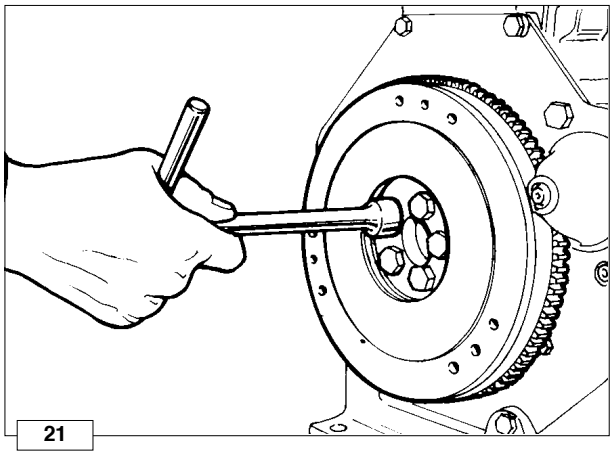
➲ See page 24 for periodic maintenance details.


20

Fuel tank (optional)

Danger - Attention
To avoid explosions or fire outbreaks, do not smoke or use naked flames during the operations.
Fuel vapours are highly toxic. Only carry out the operations outdoors or in a well ventilated place. Keep your face well away from the plug to prevent harmful vapours from being inhaled.
Dispose of fuel in the correct way and do not litter as it is highly polluting.

After disconnecting the fuel pipes unscrew the anchoring brackets' screws and remove the fuel tank.
Completely empty the tank and check that no impurities are found inside.
Check that cap breather hole is not clogged.


21

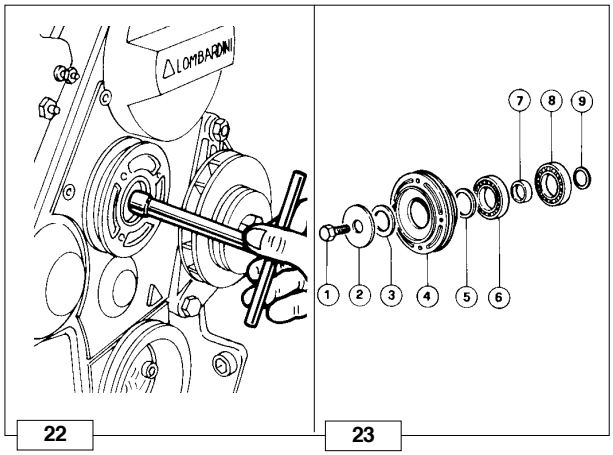
Flywheel

Danger - Attention

During dismounting be particularly careful not to let the flywheel fall, as this can be very dangerous for the operator. Use protective goggles while removing the starter ring gear.

Unscrew the screws that fasten it to the crankshaft.
In order to replace the ring gear, it is necessary to disassemble the flywheel.
Cut the ring gear in several places using a chisel and remove it.
Heat the new ring gear uniformly and keep it at a temperature of 300°C for 15÷20 minutes.
Insert the ring gear into its seat and place it carefully on the rim of the flywheel.
eave to the ring gear to cool gently before reassembling the flywheel.

❍ When refitting tighten the screws at 80 Nm.



22 23

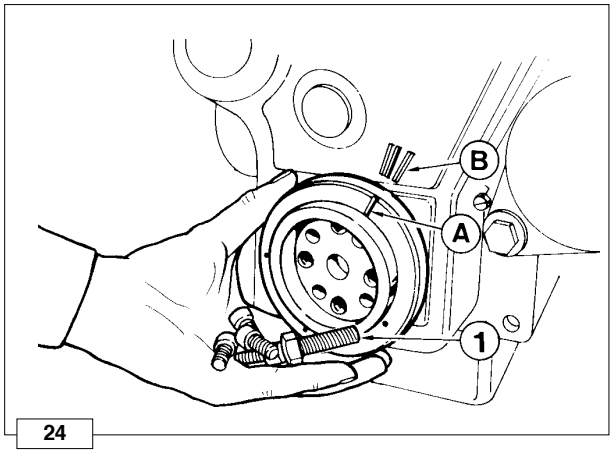
Return pulley

Remove the center bolt **1** and slide the pulley from the engine.

Components:

1 Bolt
2 Washer
3 Spacer
4 Pulley
5 Snap Ring
6 Bearing
7 Spacer
8 Bearing
9 Snap Ring

***Note*:** On remounting thoroughly clean out the threads of screw 1 and tighten at 25 Nm.



24

Driving pulley

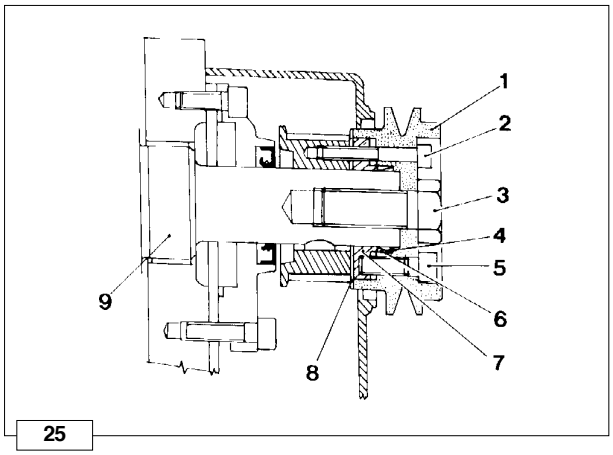
Important

To loosen or screw in screw 1 at the set torque you must always stop the crankshaft and not other parts of the engine.

Locking the crankshaft: remove the engine starter and installing the fixture tool 1460-051.
Remove the pulley, after having unscrewed central screw **1** and proceed with the four lateral screws.
The central bolt **1** is left-handed.

❍ When reassembling, apply some Moly-slip antiseizure compound on the screw thread and tighten at 360 Nm.

Note: When pulley reference mark (**A**) aligns with the timing cover reference mark (**B**), the flywheel side piston is at TDC.



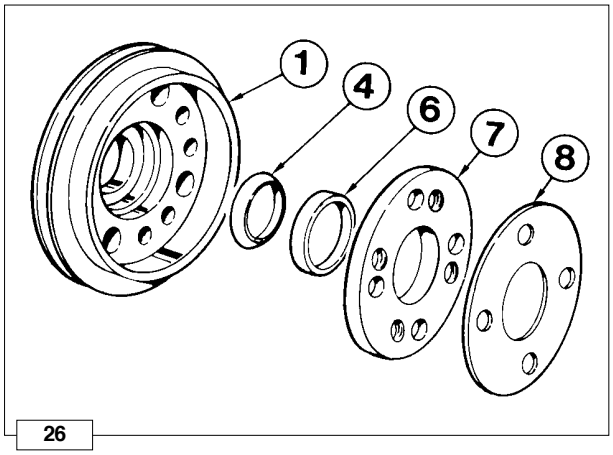
25

Ringfeder-type rings on LDW 1204-1204/T-1404

It is possible to draw ¾ of the power from the second drive of LDW 1204-1204/T-1404 engines.
If you want to draw the entire power it is necessary to mount the Ringfeder rings on the crankshaft handle.

Components:

1 Puleggia appropriata
2 Screw M6
3 Screw M16 x 1,5
4 Ringfeder internal ring
5 Screw M8
6 Ringfeder external ring
7 Spacer flange
8 Shoulder plate
9 Crankshaft



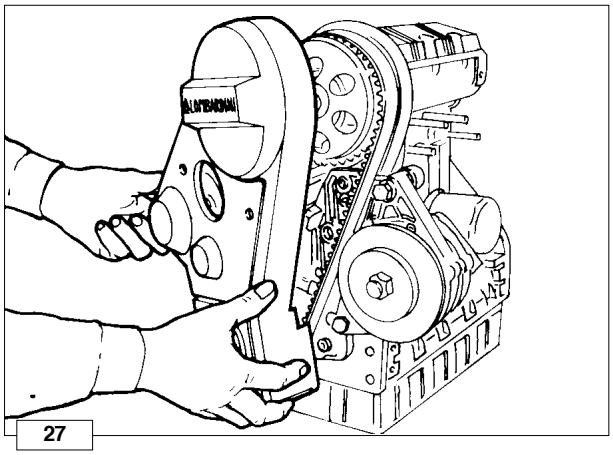
26

Ringfeder-type rings on LDW 1204-1204/T-1404 - Assembly

Refer to figures 25 and 26.
Clean and oil the parts involved in the mounting with engine oil.
Insert into pulley **1**, the internal ring **4** and the external ring **6**, then flange **7** by tightening it temporarily with its screws.
Before assembling the pulley **1** in the crankshaft taper, insert shoulder ring **8**.

Lock the crankshaft using tool 7107-1460-051.

- ❍ Tighten the screws **2** at a torque of 10 Nm.
- ❍ Tighten the screws **3** at a torque of 360 Nm.
- ❍ Tighten the screws **5** uniformly in criss-cross pattern in three distinct phases:
  1° phase = 15 Nm
  2° phase = 35 Nm
  3° phase = torque check.

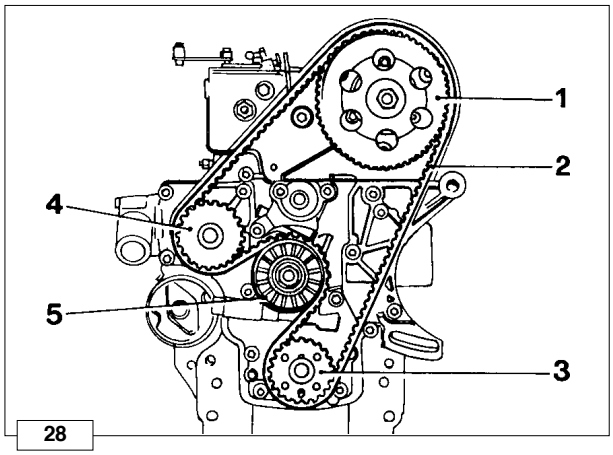

27

Timing belt cover

Loosen the five screws and remove the cover.

- ❍ When rifitting tighten the screws at a torque of 10 Nm.

Check the peripheral rubber sealing gasket and the two dust-protection rings of the two pulleys, if mounted.

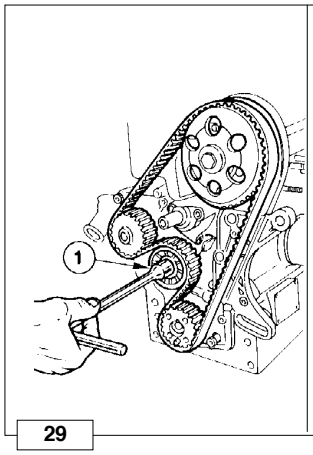


28

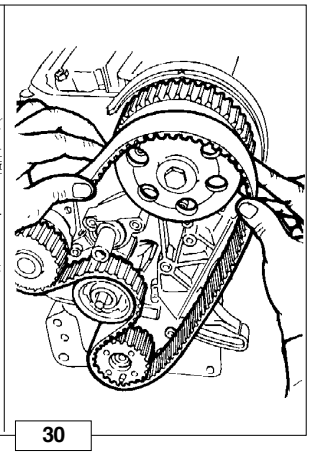
Timing belt / Timing pulley arrangement

Components:

1 Camshaft pulley
2 Timing belt
3 Crankshaft pulley
4 Coolant pump pulley
5 Belt tensioner pulley



29


30

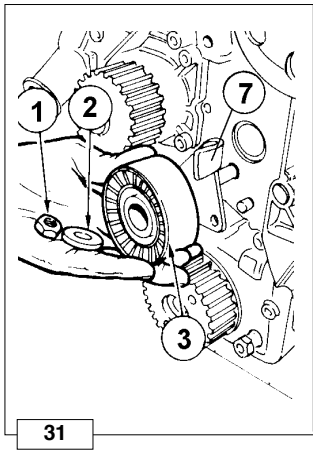
Timing belt removal

Important
When you remove the distributor belt replace it even if its prescribed operation time has not expired yet.

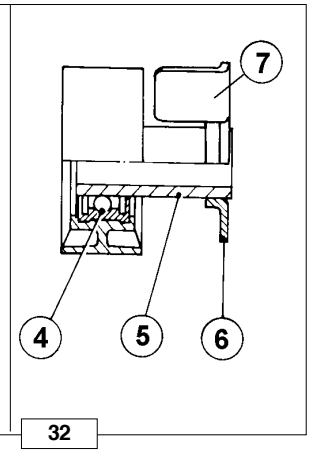
Danger – Attention
Always check that the positive pole of the battery is insulated.

Remove the belt tensioner **1**.
Remove the timing belt off the timing pulley.

➲ For assembly see fig. 36.



31

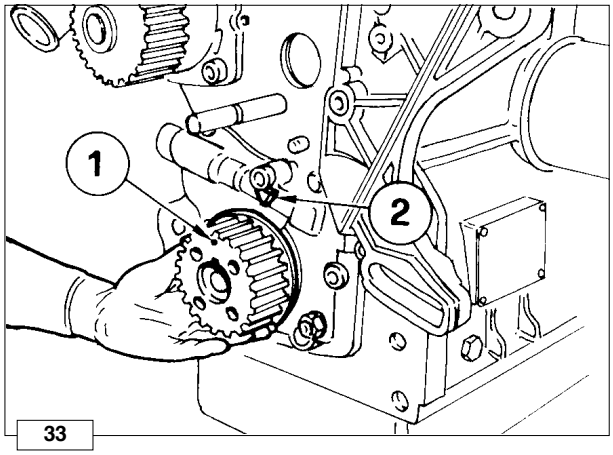


32

Tightening pulley

Components:

1 Nut
2 Washer
3 Pulley
4 Bearing
5 Shaft/Support
6 Mounting plate
7 Tensioning lever

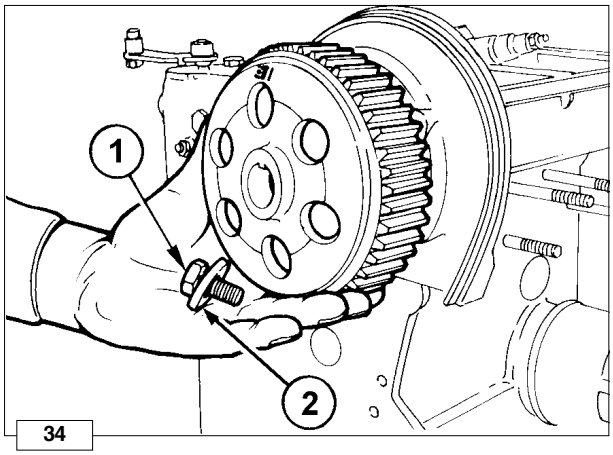


33

Crankshaft timing pulley

Al rimontaggio fare attenzione che la chiavetta rimanga inserita nella propria sede.

***Note*:** Reference mark **1** on the crankshaft timing pulley and reference mark **2** on the oil pump housing are timing marks. When aligned, No. 1 piston (flywheel side) is at TDC.



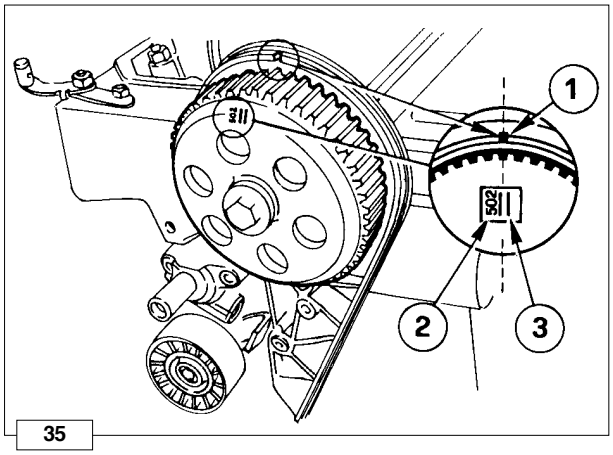
34

Camshaft timing pulley - Disassembly/Assembly

Unscrew screw 1 and remove the pulley. No extractor is needed.

❍ When refitting tighten the screw at a torque of 80 Nm.

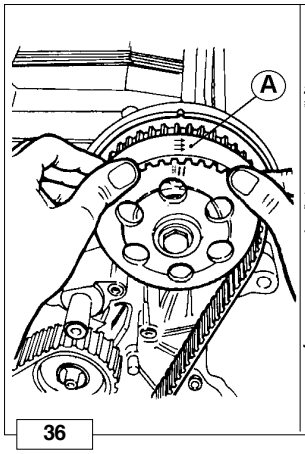
***Note*:** Assess any wear caused by the lip of the seal ring on the pulley tang.



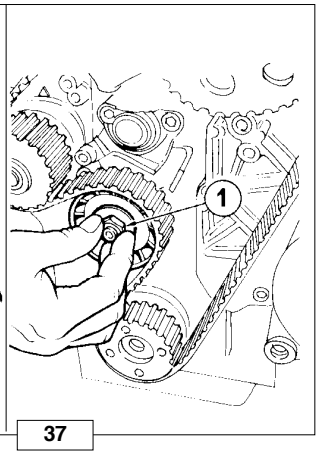
35

Camshaft timing pulley - Reference marks

1 Timing reference mark on cylinder head.
2 Camshaft pulley timing mark, for LDW 502 engines only
3 Camshaft pulley timing mark, for LDW 602, 702, 903, 1003, 1204, 1204/T and 1404 engines.



36

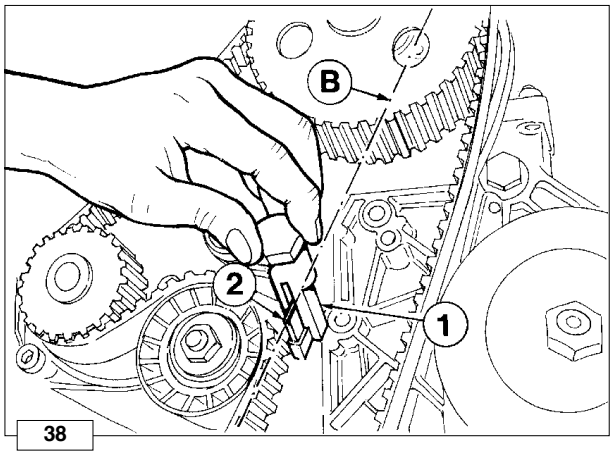


37

Camshaft timing - Belt Reassembly

Important
Remove the distributor toothed belt from its protective wrapping only when mounting it.

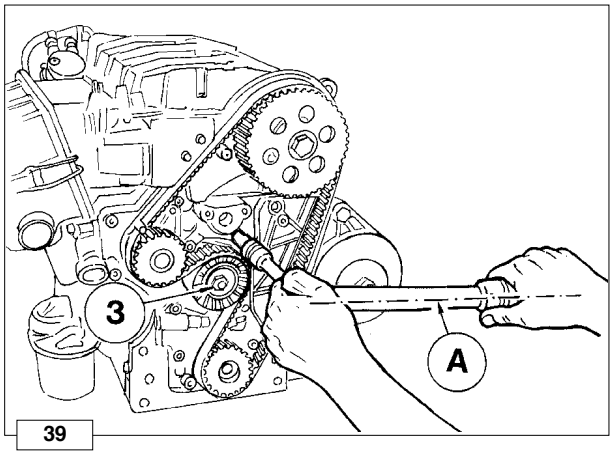
Make the connections for toothed belt fig. 33 and that of pulley fig. 34 fit together.
Insert the belt as in figure 35 taking account of the direction of the arrows **A** impressed on it (direction of rotation).
Tighten the nut **1** by hand until the belt tightener rests on surface of the crankcase.
Start by mounting the camshaft pulley belt, then mount crankshaft's pulley.
Do not mount driven belts.



38

Camshaft timing - Belt tightening tool

Position belt preload tool 7107-1460-049 **1** over the timing belt idler adjustment ear **2**.
See "Camshaft timing - Belt Tightening and Fastening".



39

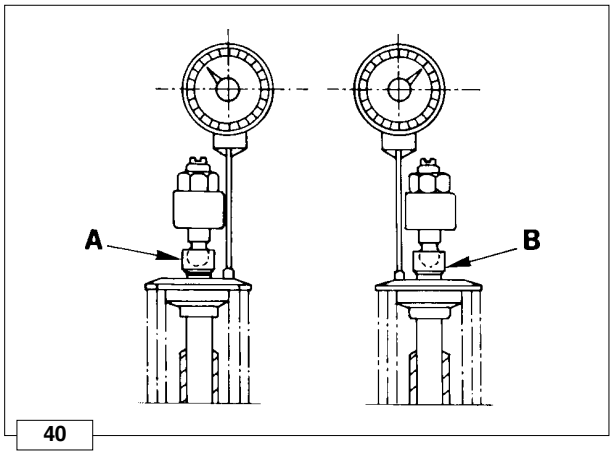
Camshaft timing - Belt Tightening and Fastening

Insert the torque wrench in the suitable tool so that the **A** axis of the key fig. 39 is at 90° to the **B** axis of the tool in fig. 38.
Tighten in clockwise direction at 20 Nm.

❍ Maintaining the belt tension, tighten nut 3 with another torque wrench at 40 Nm, after having remounted the drive pulley.

Rotate the crankshaft a few times and check that the tension is as described above.

The check must be carried out with the appropriate Nippon Denso tension measuring instrument (halfway along the longest section of the belt), the value for a cold engine must be 15±2Kg.

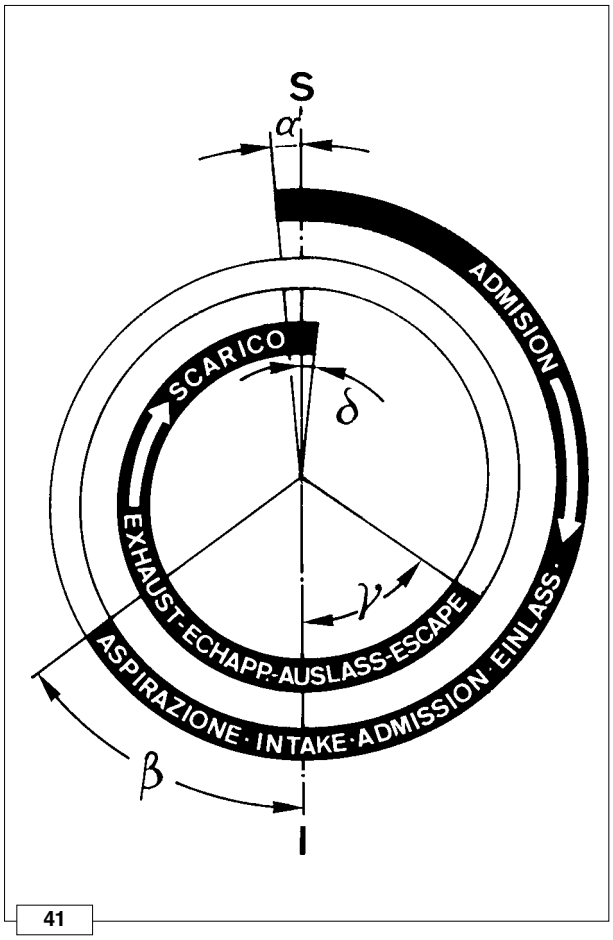


40

Valve timing check

A = Intake valve
B = Exhaust valve

Rotate the engine in the normal direction of rotation until the No. 1 piston (flywheel side) approaches TDC- compression stroke
Check the balance of intake and exhaust valves **A** and **B** placing the two micrometers testers on the valve collars.



41

Valve timing - Angles

The angle values are determined by turning the driving shaft clockwise.

S = Piston at top dead centre
I = Piston at bottom dead centre

α = Intake valve open
β = Intake valve closed
γ = Exhaust valve open
δ = Exhaust valve closed

Timing angles for operating purposes
(valve clearance = 0.25 mm)

α = 16° before **S**
β = 36° after **I**
γ = 36° before **I**
δ = 16° after **S**

Timing angles for checking puposes
(valve clearance = 2 mm)

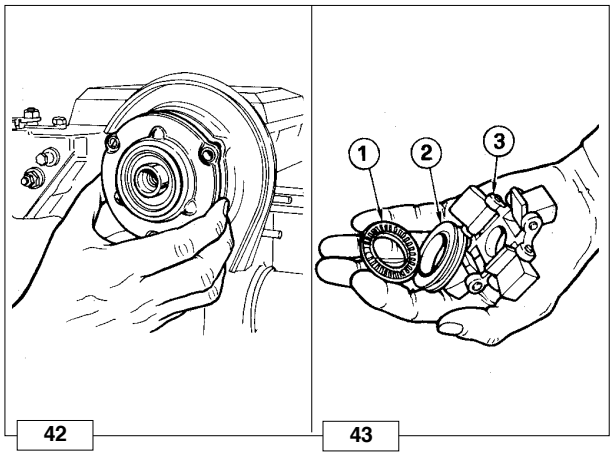
α = 21° after **S**
β = closes in **I**
γ = 2° after **I**
δ = 20° before **S**

Timing angles for operating purposes - LDW 1204/T
(valve clearance = 0.25 mm)

α = 10° before **S**
β = 42° after **I**
γ = 56° before **I**
δ = 16° after **S**

Timing angles for checking puposes - LDW 1204/T
(valve clearance = 2 mm)

α = 31° after **S**
β = 1° after **I**
γ = 11° before **I**
δ = 29° before **S**



42 43

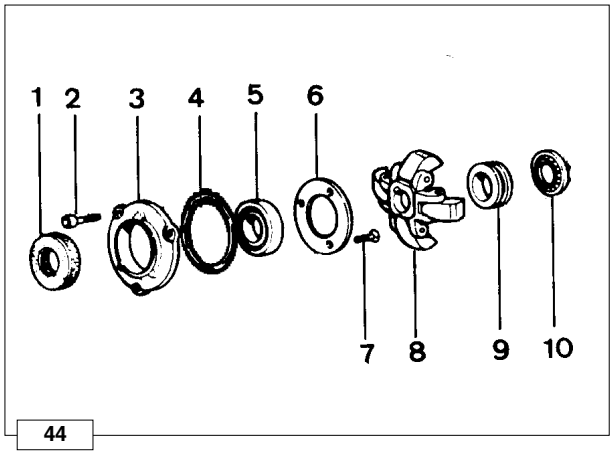
SPEED GOVERNOR

The weight-type mechanical governor, is driven directly by the camshaft and is housed with the cylinder head.

Components:

1 Thrust washer
2 Spool
3 Flyweight assembly

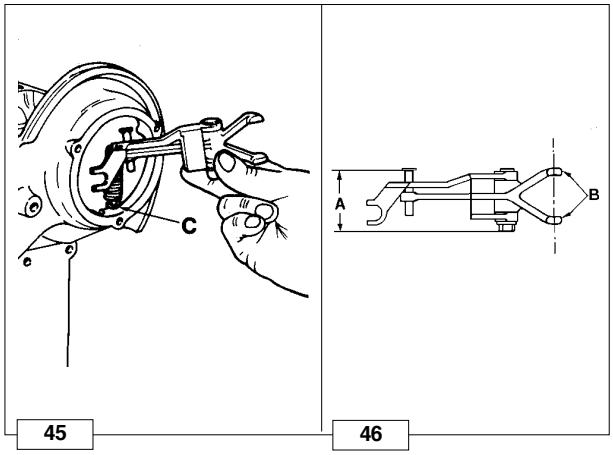
***Note*:** In engines with the minimum/maximum (see fig. 49) the weights are lightened by 25%.



44

Speed governor components

1 Oil seal
2 Screw
3 Support
4 O-Ring
5 Bearing
6 Retainer
7 Screw
8 Flyweight assembly
9 Spool
10 Thrust washer

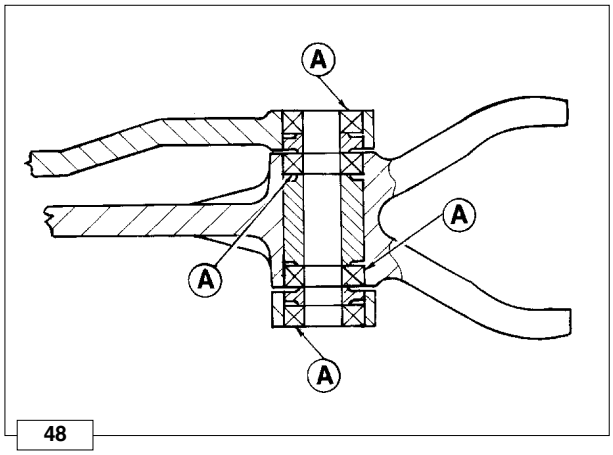


45 46

Governor springs

Unscrew the pin that attaches it to the cylinder head.
To remove it as shown in the figure it is necessary to dismount the camshaft. It could also be removed from the accelerator box side by unscrewing the torque gearing device.
Before reassembling it, check value **A** (45 to 46 mm) and the parallelism of the two levels **B** that must not exceed 0.05 mm.

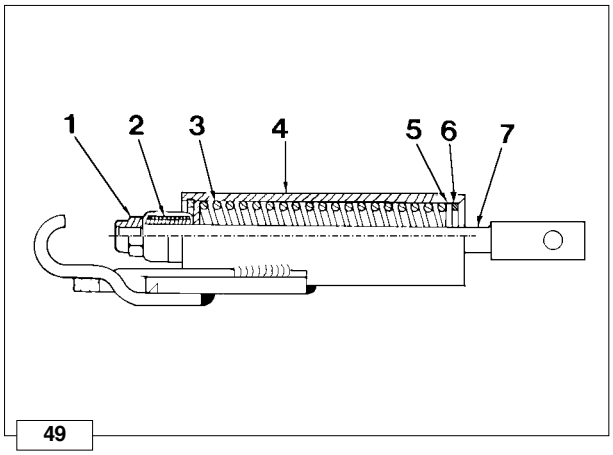
***Note*:** There are 5 different types of regulator springs **C**. These change according to the engine adjustment: standard spring for 3,600 rpm, for 3,000 rpm, for 2,400 to 2,600 rpm, for 1,800 rpm and for 1,500 rpm.



48

Governor springs for Gensets

In the section view of the leverages the 4 ball bearings **A** are highlighted.
They are mounted on engines for generator sets adjusted at 1,500÷1,800 rpm and on other particular applications on request.



49

Speed governor - Limiting speed governor

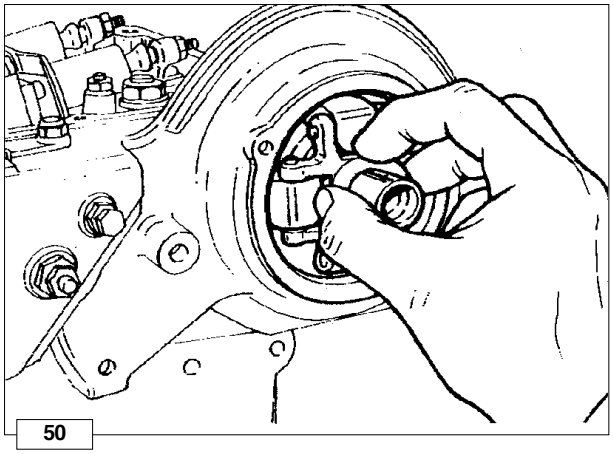
With applications for the automotive sector the regulator spring C fig. 45 is replaced by a device (plunger barrel) that only enables a constant speed at the minimum and maximum rpm rating.

Components:

1 Nut
2 Idle speed spring
3 Max. speed spring
4 Case
5 Register
6 Spring ring
7 Actuation rod

***Note*:** There are six maximum springs in a different colours, to distinguish them from the six respective adjustments.

Red color for ..... 3000 giri/1'
No color ..... 3200 giri/1'
Black ..... 3600 giri/1'
Orange ..... 3750 giri/1'
White ..... 4200 giri/1'
Green ..... 4300 giri/1'.
Brown ..... 4500 giri/1'


50

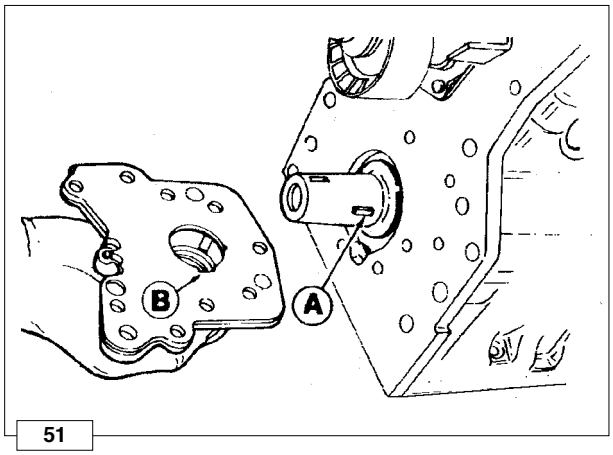
Speed governor - Reassembly

Caution – Warning
While reassembling, check the integrity of the components and check that they operate correctly.
Bad operation of the speed governor can cause serious damage to the engine and to people being near to it.

Remount in reverse order to Fig. 44.
When inserting the bearing in the camshaft, do it so that the four blocks enter opened, so that they can receive the hose and close over it.
Check the integrity of the sealing rings of the cover.

❍ Tighten the three screws at a torque of 10 Nm.

Note: With the speed governor mounted the camshaft axial clearance should be zero.

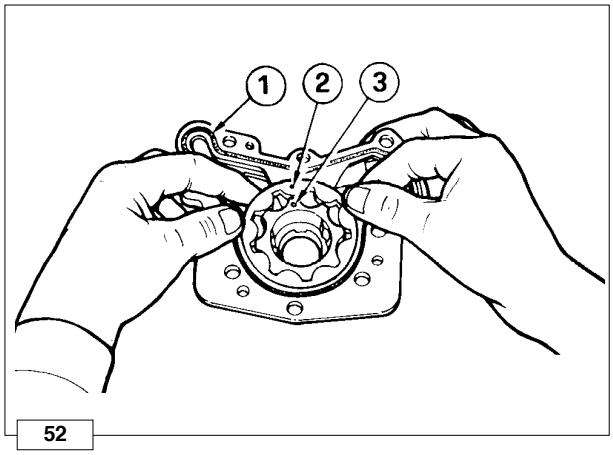


51

Oil pump - disassembly

The FOCS oil pump is supplied as an assembly. Lombardini therefore recommends that the oil pump be handled as an assembly from a service standpoint
Lombardini does not recommend that the oil pump be disassembled, then reassembled for purposes of installation on the engine except during emergency situations.

Rotate the crankshaft until the crankshaft timing pulley keyway is vertical as shown. Remove the oil pump assembly retaining bolts. When the crankshaft timing pulley keyway is vertical, the oil pump drive keyway (**A**) will be at 3:00 o'clock allowing removal of the oil pump assembly via relief (**B**).



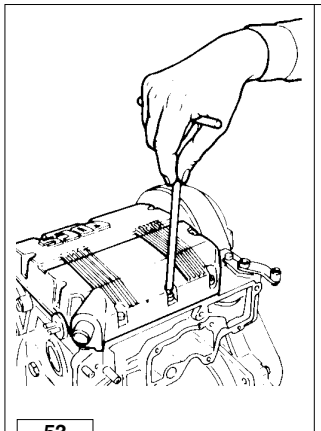
52

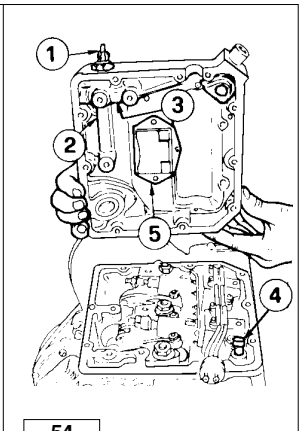
Oil pump - Reassembly

The pump rotors should be coupled on the same side, see references **2** and **3**.
Replace the O-ring **1**.

❍ Tighten the fastening screws to the crankcase at 25 Nm and those of the plate at 10 Nm.

➲ See page 69 for technical details.


53



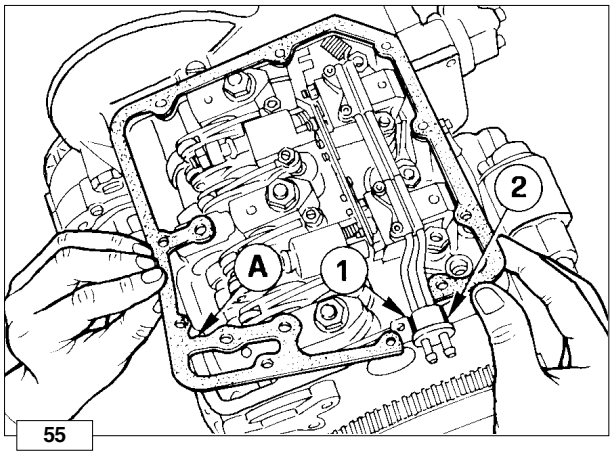
54

Rocker arm cover

The engine control components are all on the cylinder head.
The cover contains part of the lubrication duct of the camshaft and of the rocker arms, as well as part of the engine vent system.

Components:
1 Oil preassure switch
2 Camshaft lubrification port
3 Rocker arm lubrification port
4 Oil exhaust hose from sump vent system
5 Air valve with oil decanting wire gauze

Note: During remounting be careful with oil exhaust hose **4** that needs to be properly inserted into its housing on the cylinder head.

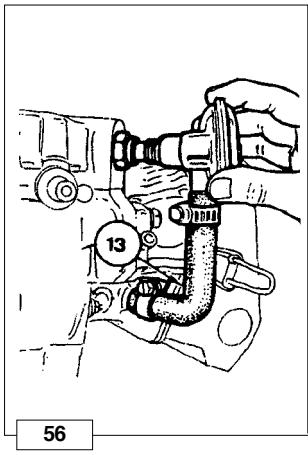


55

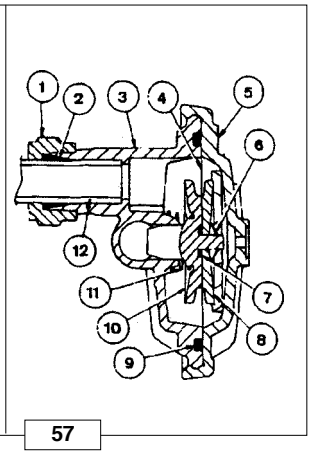
Rocker arm cover gasket

The rocker arm cover gasket **A** ensures the seal of the lubrication circuit for the camshaft and rocker arm shaft.
Always replace it and mount it with especial care above all in zones **1** and **2** where, for greater safety, it is advisable to apply a few drops of silicon sealant.

❍ Tighten the rocker arm cover screws at a torque of 9 Nm.



56

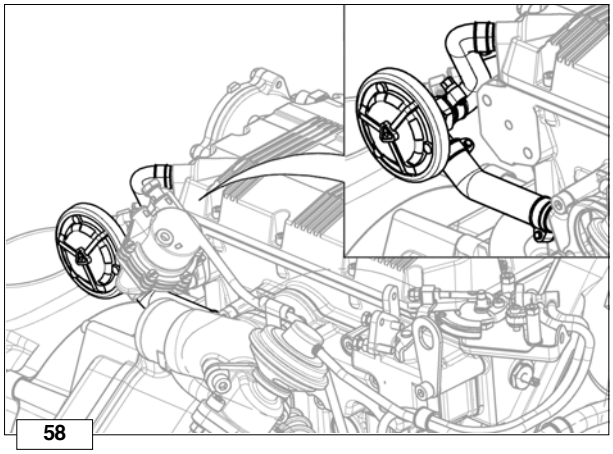


57

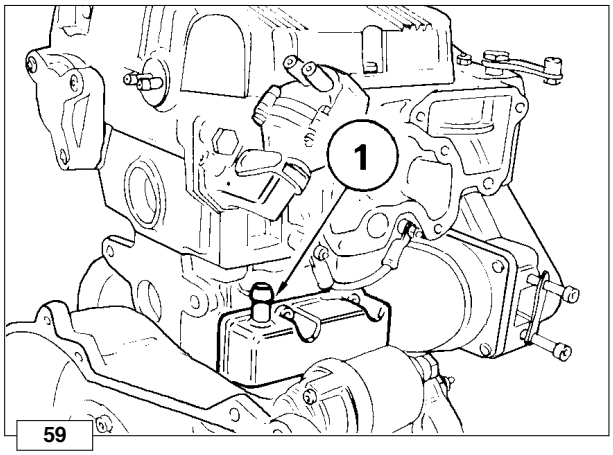
Crankcase vacuum regulator valve

Components:

1 Gland Nut
2 Bushing
3 Body
4 Diaphragm
5 Cap / Cover
6 Clip / Lock
7 O-Ring
8 Washer
9 O-Ring
10 Valve
11 Spring
12 Tube
13 Hose


58

The vacuum relief valve is an engine safety device.
Its function is that of limiting the vacuum whenever it tends to increase.
Without this, should the air filter be clogged, the oil contained in the carter may be sucked back into intake manifold causing the condition for engine runaway.

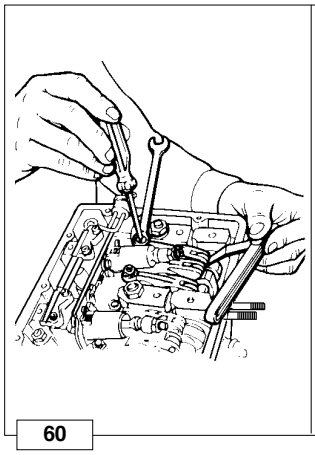


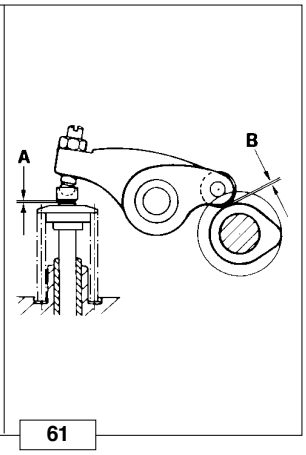
59

~~Crankcase breather LDW 502~~

For LDW ~~602 702 903 1003 1204 1204/T~~-1404 engines, the exhaust gases exit from the cylinder head cover, see Fig. 53, 54.
~~In the LDW 502 engine the exhaust gases exit directly from the crankcase via cover~~ **1**.

Remove the cover, check the integrity of the air valve and oil decanting wire gauze.


60

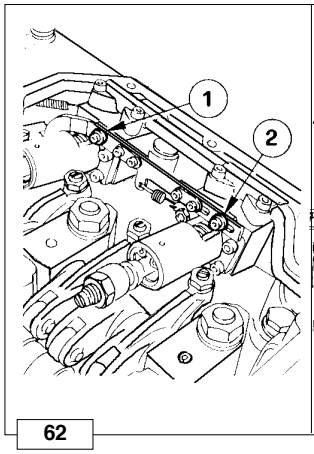


61

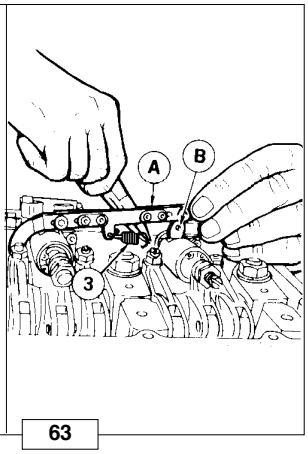
Valve / Rocker arm clearance

Important
Setting should be performed when the engine is cold.

Bring each cylinder piston to top dead center on the compression stroke and set clearance **A** at 0,20 mm for both the intake and exhaust valves.
For greater convenience, clearance check **B** is accepted. In this case the value is 0.15 mm.



62

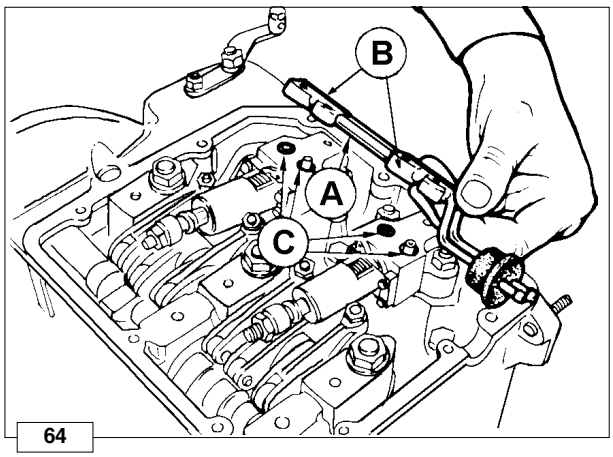


63

Injection pump control rod

Depending on the engine model, the injection pump control rod will link two, three, or four injectors to the engine governor.
Screws **1** and **2** are pivoted on the delivery control lever of each pump/injector **B**, unscrew the screws and remove spring **3**.
When refitting tighten the screws **1** and **2** at a torque of 1,1 Nm and make sure that they stop on lever **B** of each pump/injector and not on rod **A**.

- ➲ To carry out the delivery equalisation of the injection pumps see page 83.
- ➲ To carry out the timing of the injection pumps and speed governor see page 95

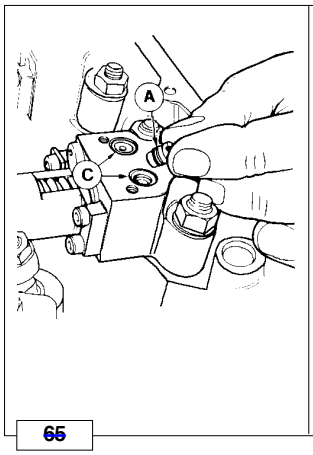


64

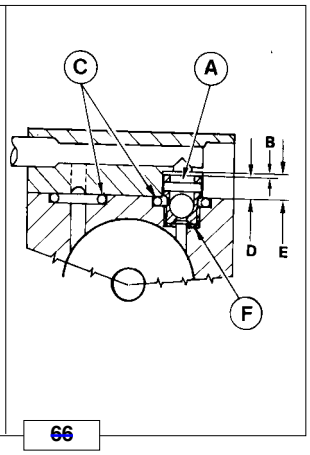
Fuel rail

When removing the fuel feeding pumps **A**, with the rail holders **B**, pay attention that the sealing O-rings **C** remain in their seats.

- ❍ When refitting tighten the rail holder screws at a torque of 4 Nm.



65



66

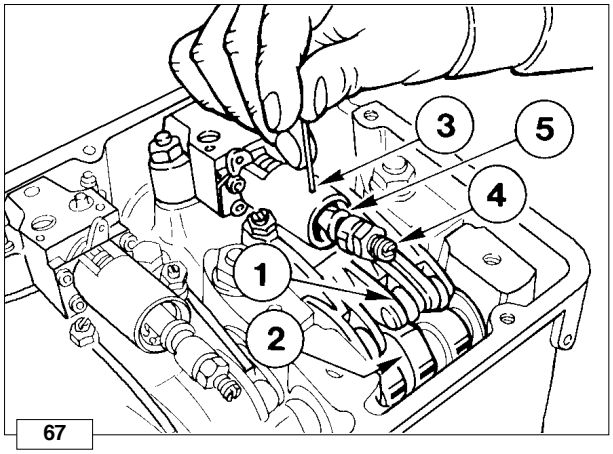
Pump/injector unit - non-return valve

Non-return valve **A** immediately stops the engine whenever the stop is activated.

Dimensions (mm):

LDW 502 602 903 1204		
B	D	E
1,0 : 1,85	5,25 : 6,0	7,0 : 7,1
LDW 1204/T		
B	D	E
0,5 : 1,15	5,05 : 6,5	7,0 : 7,1

Note: If the value of **B** is not achieved, the two rings **C** are not subject to enough compression to ensure the seal; any fuel loss would contaminate the lubrication oil and consequently damage the engine, **F** = metal gasket.

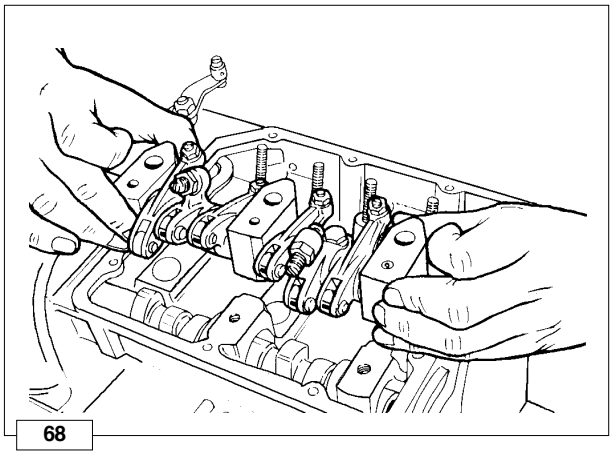


67

Pump/injector unit - Disassembly

When the removal (but not replacement) of a unit injector is required the following procedure may be used to avoid the need for other adjustments:
Rotate the engine until the unit injector cam lobe **2** forces the cam follower **1** to the highest position, then insert a suitable sized (hardened) pin into the hole **3** and rotate the engine until the cam follower **1** is at the lowest position. In this way the injection advance regulator 4 remains calibrated.

Note: If you dismount more than one pump/injector unit, make sure to reinstall them in the appropriate housing (with relative drive rod **5**); before mounting lubricate the drive rod at its two ends with MOLYSLIP, AS COMPOUND 40 type.


68

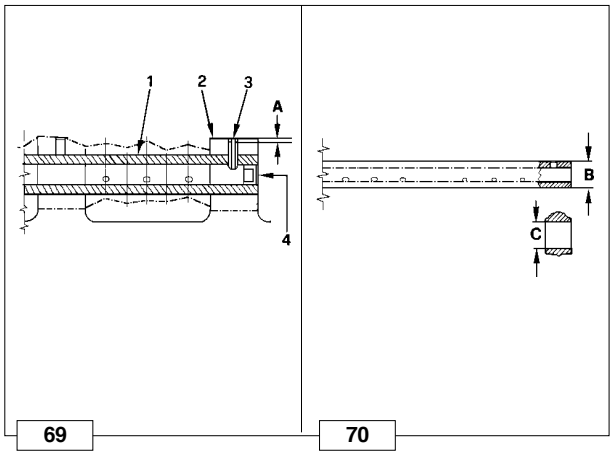
Rocker arm assembly

Remove the nuts attaching the rocker arm assembly to the cylinder head.

❍ When refitting tighten the nuts at a torque of 40 Nm.

The pin, that is hollow inside to allow lubrication, is closed at its ends by two caps.

Note: The rocker arm assembly may be removed without removal of the unit injectors.



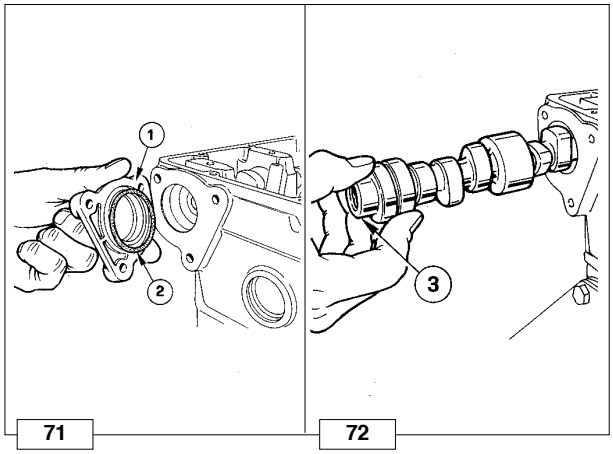
69 70

Rocker arm pivot, dismounting and remounting

To remove pivot **1** from the support **2** it's necessary to drill out pin **3** using a 4mm drill bit.
On remounting insert a new pin and reinsert it in bearing surface **A** (0 to 1 mm).
Check the rod's state of wear and tear (diam. **B**) and that of the rocker arm holes (diam. **C**).
Remove the closing caps **4** at the end and carefully clean inside.

Dimensions (mm):

	mm	C-B	C-B **limit value**
A	0 ÷ 1,00		
B	17,989 ÷ 18,000	0,015 ÷ 0,041	0,090
C	18,015 ÷ 18,030		



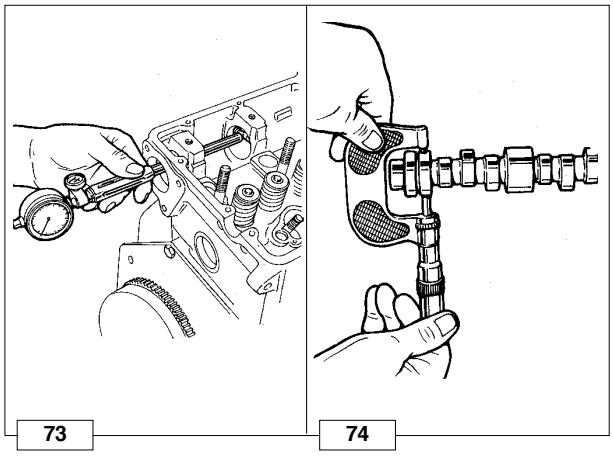
71 72

Camshaft, disassembly

Loosen the screws and remove the cover **1**.
Check gasket ring **2** for integrity.
Remove the drive rod from the fuel pump.
Gently remove the camshaft, slight rotations may be required to avoid binding the camshaft lobes against the camshaft bearing surface bores.

Note: The lift pump drive eccentric 3 is included on the flywheel end of the camshaft and fixed with a screw.

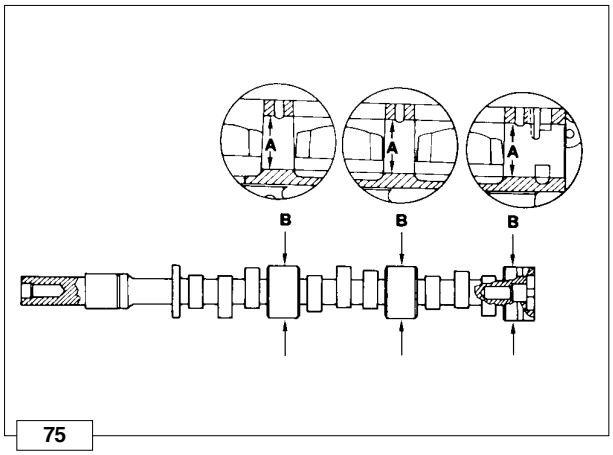
❍ In case of replacement tighten the eccentric screw at a torque of 80 Nm.



73 74

Camshaft, journal and housing measurement

Use an inside micrometer gauge for housing diameters and an outside micrometer gauge for journal diameters.

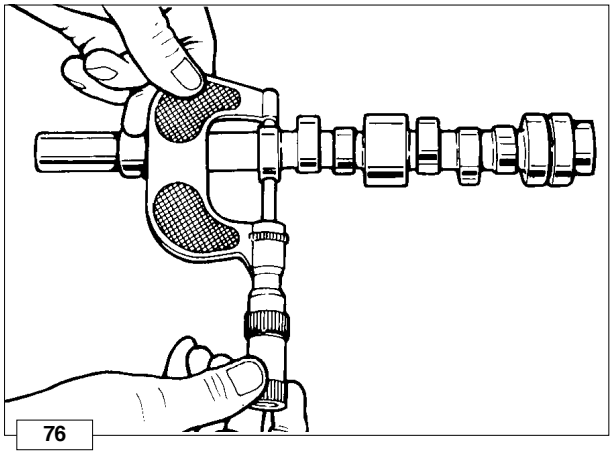


75

Camshaft journals and housings - Dimensions (mm)

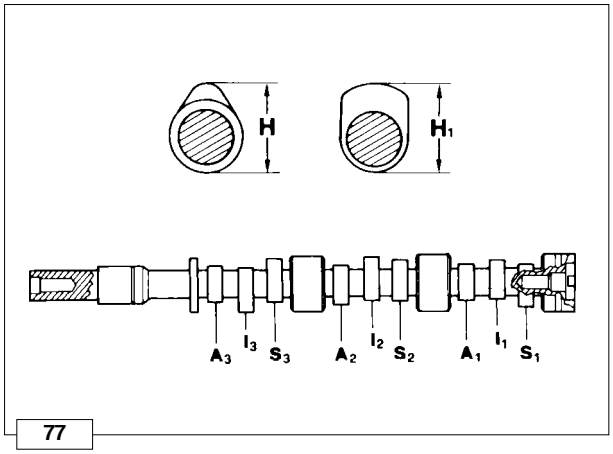
A	B	A-B	A-B limit value
37,035 ÷ 37,060	36,975 ÷ 37,000	0,035 ÷ 0,085	0,170

Note: The camshaft journal and cylinder head camshaft bore dimensions are identical for all LDW-FOCS series engines (LDW ~~-502-602-702-903-1003-1204-1204/T-~~1404).


76

Camshaft lobe measurement

Use an outside micrometer gauge.



77

Intake / Exhaust / Injection camshaft lobe height - LDW 903

A1 = 1st cylinder intake camshaft lobe
A2 = 2nd cylinder intake camshaft lobe
A3 = 3rd cylinder intake camshaft lobe

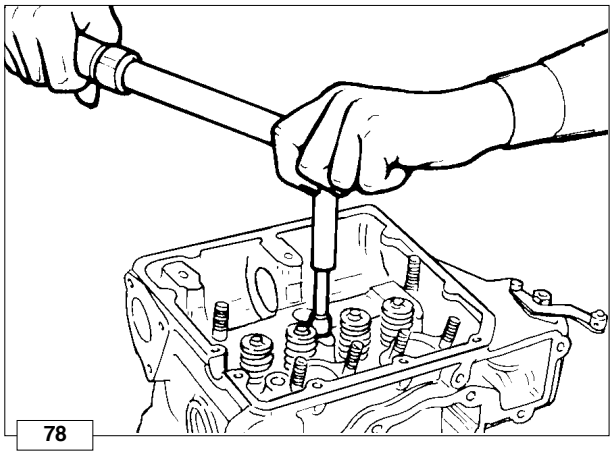
I1 = 1st cylinder injection camshaft lobe
I2 = 2nd cylinder injection camshaft lobe
I3 = 3rd cylinder injection camshaft lobe

S1 = 1st cylinder exhaust camshaft lobe
S2 = 1st cylinder exhaust camshaft lobe
S3 = 1st cylinder exhaust camshaft lobe

H = 29,598÷29,650 mm (intake/exhaust camshaft lobe height)
H1 = 28,948÷29,000 mm (injection camshaft lobe height)

For 1204/T : **H** (intake) = 29,438÷29,490 mm,
H (exhaust) = 29,778÷29,830 mm.

All engines in the series (except LDW 1204/T) have intake exhaust and injection cams with the same height of **H** and **H1**.
If wears on the cams exceeds by 0.1 mm the minimum value given **H** and **H1**, replace the crankshaft.

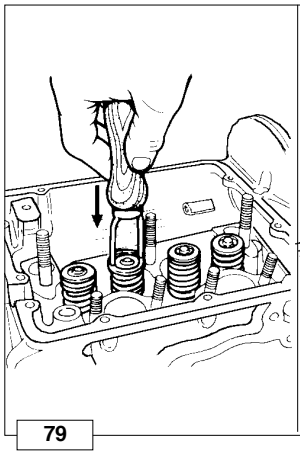

78

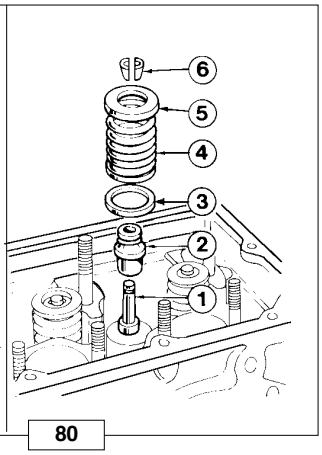
CYLINDER HEAD, removal

Important
Do not remove the cylinder head when hot to avoid deformation.

If cylinder head is deformed by more than 0.10 mm, level it off by removing a maximum of 0.20 mm.

➲ For the cylinder head tightening procedure see page 57.


79

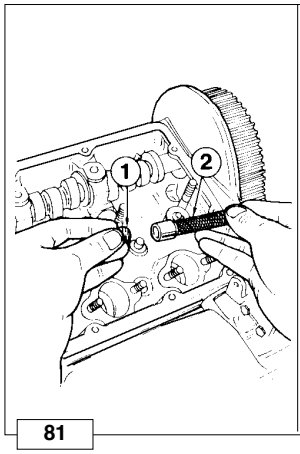


80

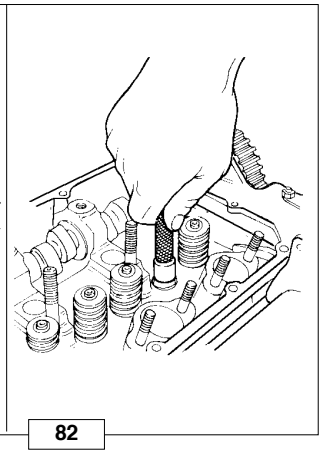
Valves

To remove the valves it is necessary to remove the collets; place a spacer under the valve head, press strongly on the spring cap as shown in the picture.

Components:
1 Valve stem
2 Valve stem seal ring
3 Spring seat
4 Spring
5 Spring cap
6 Collets

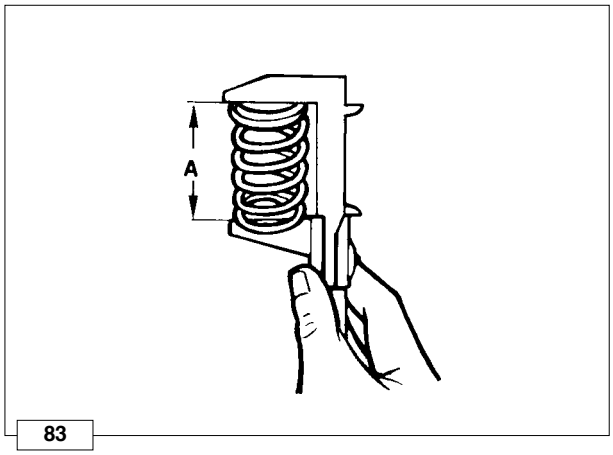


81


82

Valve stem sealing rings - Reassembly

To prevent deformation of the sealing ring **1** as it is inserted onto the valve guide, insert it onto tool "7107-1460-047" **2** (after lubricating the sealing ring) and proceed as shown int the picture ensuring that gasket **1** is completely fitted.



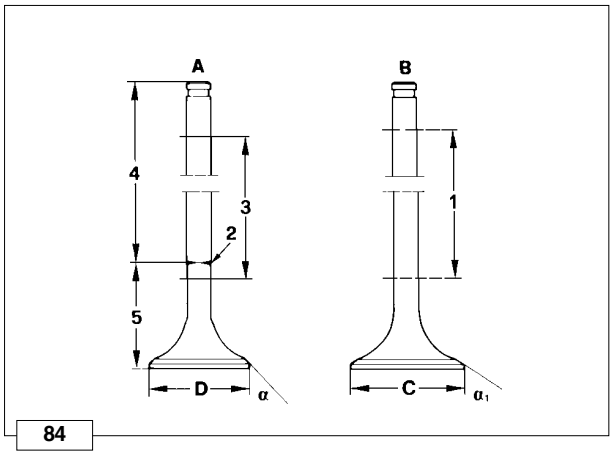
83

Valve springs

Measure free height with a gauge.

Free height **A** = 46 mm.

Note: If the free height **A** is less than 43,5 mm replace the spring.



84

Valve, specifications

Exhaust valve A
Shaft and head are made of 2 different materials.

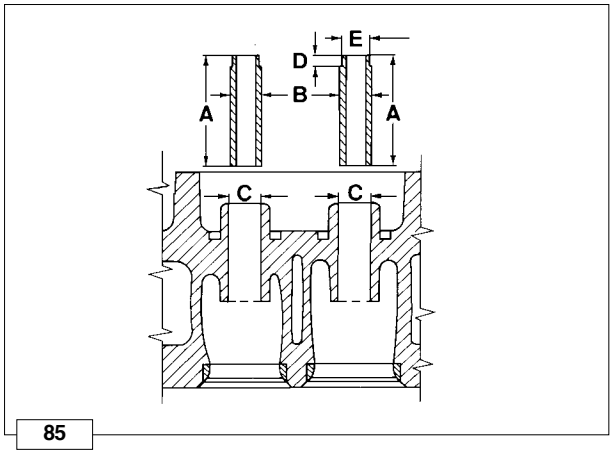
2 Welded joint
3 Chromium-plated joint
4 Portion made of: ..... X 45 Cr Si 8 UNI 3992
5 Portion made of: ..... X 70 Cr Mn NI N 216 UNI 3992

	~~502 602 903 1204 1204/~~T	~~702 1003~~-1404	~~α~~
D	~~29,00~~	30,20	45° 30' ÷ 45° 45

Intake valve B
Material: X 45 Cr Si 8 UNI 3992

1 = Chromium-plated joint

	~~502 602 903 1204 1204/~~T	~~702 1003~~-1404	α_1
C	~~33,00~~	34,40	60° 30' ÷ 60° 45'



85

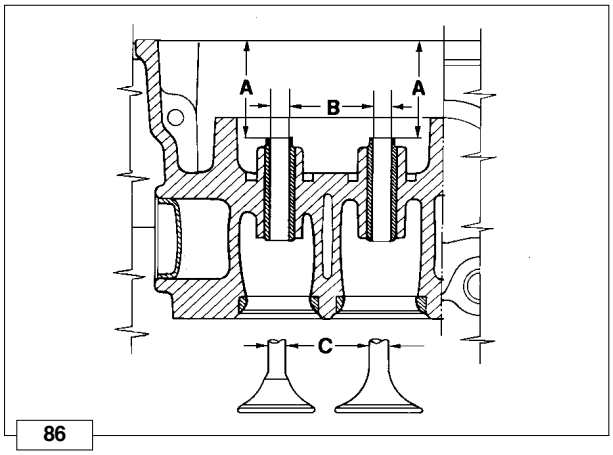
Valve guides and valve guide housings

Both intake and exhasut valve guides are identical dimensionally and are made from phosphoric gray iron with a pearlitic matrix:

Dimensions (mm):

A	B	C	D	E
36,4÷36,6	11,045÷11,054	11,000÷11,018	5,80÷6,20	9,75÷9,85

Note: Valve guides are supplied in finished form, <u>further machining is prohibited</u>.
Valve guides with outside diameter **B** increased by 0.5 mm. are available.



86

Valve guide insertion

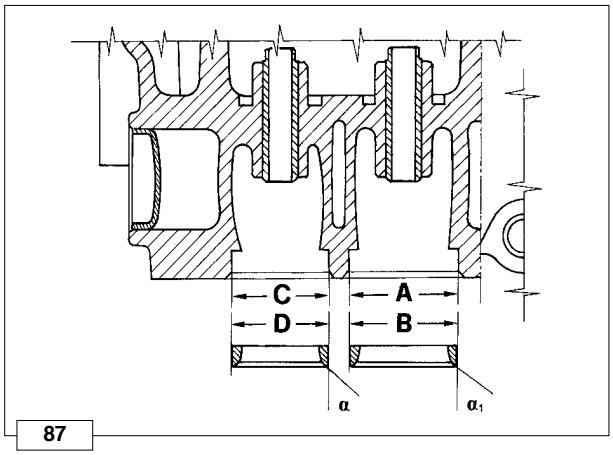
Fit the guides with a punch taking account of value A in relation to the cylinder head surface.

Dimensions (mm):

A	B	C
39,5 ÷ 40,0	7,005 ÷ 7,020	6,960 ÷ 6,990

Clearance (mm):

(**B-C**) = 0,015÷0,050 (**B- C**) limite usura = 0,10



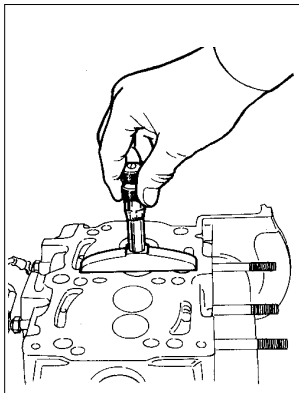
87

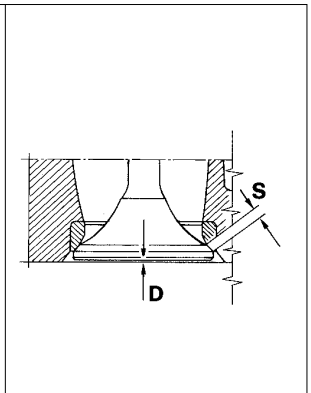
Valve seats and housings - Dimensions

~~LDW 502-602-903-1204-1204/T~~			
	~~mm~~	~~α~~	~~α1~~
~~A~~	~~34,020÷34,045~~	~~44° 53' ÷ 45°~~	~~59° 53' ÷ 60°~~
~~B~~	~~34,106÷34,115~~		
~~C~~	~~30,020÷30,041~~		
~~D~~	~~30,108÷30,116~~		
LDW ~~702-1003~~ - 1404			
	mm	**α**	**α1**
A	35,220÷35,245	44° 53' ÷ 45°	59° 53' ÷ 60°
B	35,306÷35,315		
C	31,220÷31,241		
D	31,308÷31,316		

Press valve seats into the housings

Note: Valve seatsare supplied in finished form, further machining is prohibited.


88



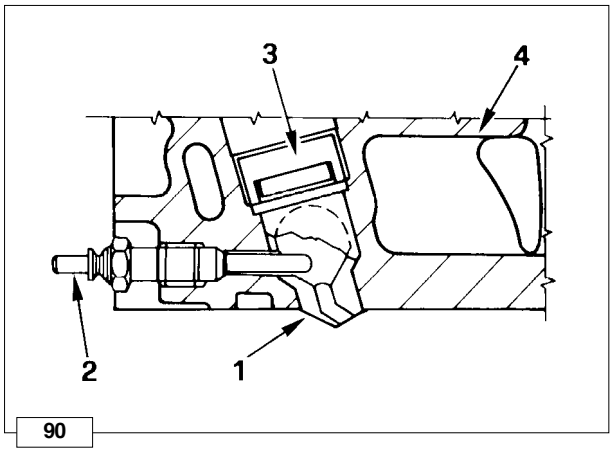
89

Valve recess and seat sealing width

Dimensions (mm):

~~LDW 502-602-903-1204-1204/T~~		
	~~mm~~	
~~D~~	~~0,5÷0,8~~	~~1,1~~
~~S~~	~~1,6÷1,7~~	~~2,0~~
LDW ~~702-1003~~ - 1404		
	mm	
D	0,7÷1,0	1,3
S	1,6	2,0

Grind valve seats with fine emery paste.
After grinding check the valve recess **D** relative to the cylinder head surface and the seat sealing width **S**.



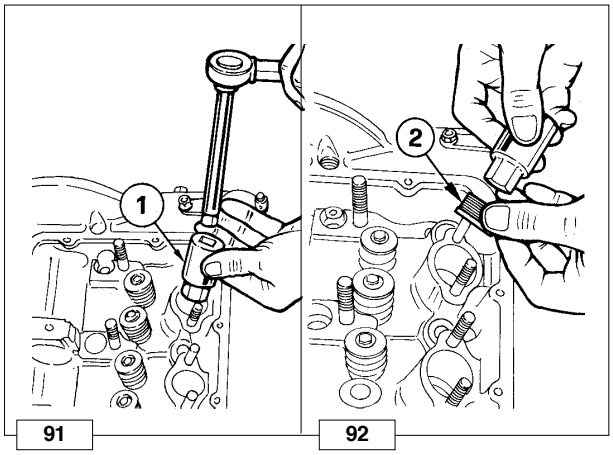
90

Pre-combustion chamber

Components:

1 Pre-combustion chamber
2 Pre-heating glow plug
3 Pre-combustion chamber ring nut
4 Cylinder head

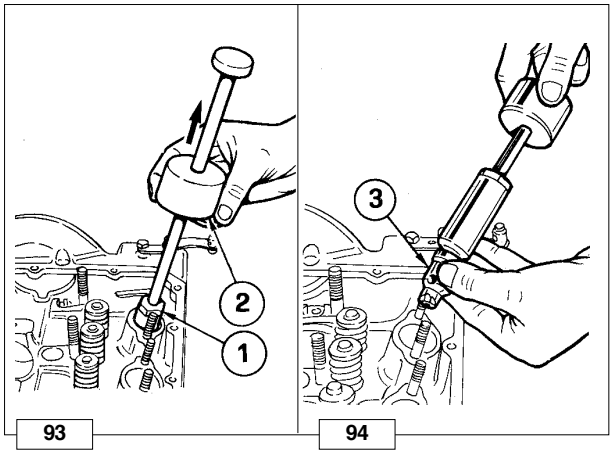
The pre-combustion chamber does not normally require removal or service, if service is necessary follow the procedure described below.



91 92

Pre-combustion chamber ring nut removal

The pre-combustion chamber is fixed to the cylinder head by a ring nut, so before removing the pre-combustion chamber it is necessary to unscrew the pre-combustion chamber ring nut.
Use the special tool "7107-1460-027" **1** to romve the ring nut **2**.

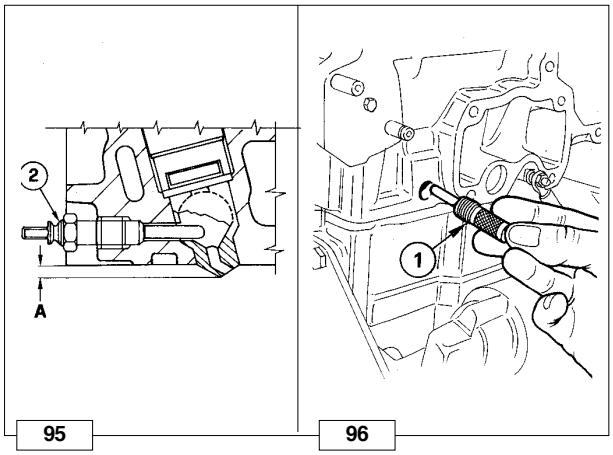


93 94

Pre-combustion chamber, removal

Before proceeding with removing the pre-combustion chamber it is necessary to remove the pre-heating glow plug.
Screw special tool "7107-1460-030" **1** into the pre-combustion chamber.
Carefully, but sharply, slide the slide hammer **2** up the special tool shaft until contact is made with end of the tool. The hammer effect of the special tool will extract the pre-combustion chamber **3**.

Note: There are many types of precombustion chambers for the various engines described as follows.
- LDW 502
- LDW 602-903-1204-1204/T.
- LDW 702-1003-1404.



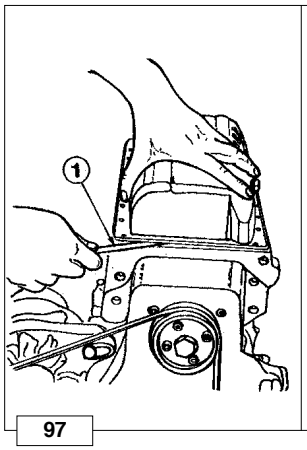
95 96

Pre-combustion chamber, installation

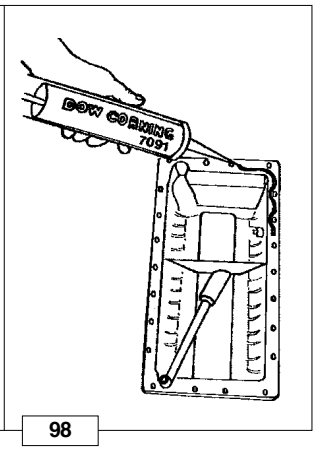
The pre-combustion chamber has a hole on the side where the pre-heating glow plug **2** must be inserted.
When re-fitting introduce the the new pre-combustion chamber into the cylinder head so that the side hole of the pre-combustion chamber aligns with the glow-plug hole.
To make sure that both the holes align appropriately use tool "7107-1460-031" **1** inserting it into the glow-plug hole.

❍ Tighten the ring nut twice:
1st tighten at a torque of 100 Nm,
2nd tighten at a torque of 180 Nm.

Chack that clearance **A** is 3,68÷4,1 mm.



97



98

Oil pan, removal

Danger - Attention

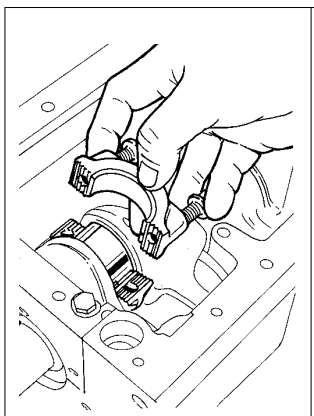
- **The used engine oil can cause skin-cancer if kept frequently in contact for prolonged periods.**
- **If contact with oil cannot be avoided, wash carefully your hands with water and soap as soon as possible.**
- **Do not disperse the oil in the ambient, as it has a high pollution power.**

Remove the fixing screws.
Insert a spacer **1** in the forward and rear main bearings.
Detach the silicon from the main bearing rubber bulb seals.

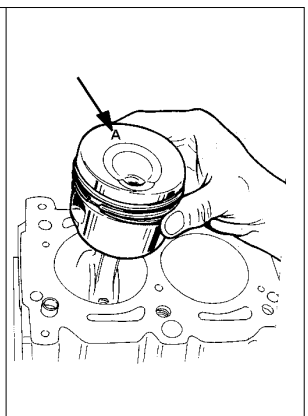
When re-mounting apply Silicone **" Dow Corning 7091"** as shown in the picture.

❍ Tighten the screws at a torque of 10 Nm.

Before starting the engine make sure that:
1) the oil drain plug is tightened correctly
2) the engine has been refilled with the prescribed quantity of oil (see page 26).



99

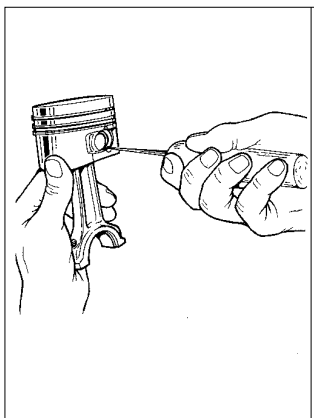


100

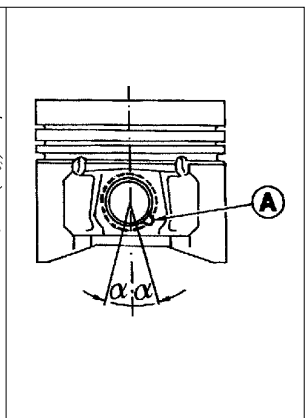
PISTON

Remove the connecting rod big end cap.
Remove the piston-connecting rod assembly.

Note: ~~The LDW 502's piston is different from the LDW 602 in terms of its combustion chamber.~~
~~The LDW 1204/T piston is different from that of the LDW 1204 in term of its cooling nozzle's slot bleed and an insert in the first section's hollow.~~
The Ricardo type of combustion chamber is used for LDW ~~702-100~~3-1404 engines.



101

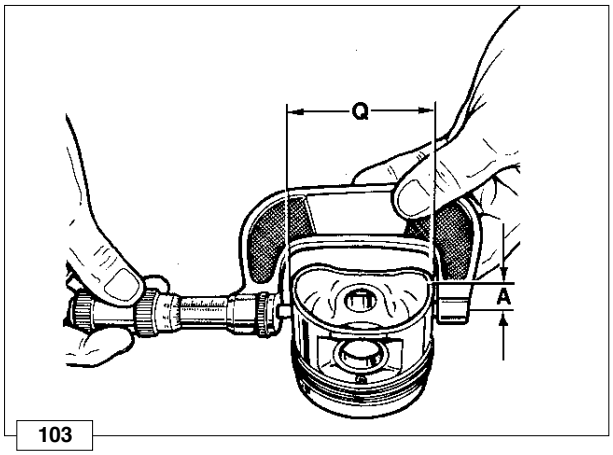


102

Stop pin rings, dismounting and remounting

Extract the ring inserting a pointed tool in hollow A.

On remounting, insert rings with the points turned downwards inside the corners (α = 15°).



103

Piston, disassembly and inspection

Remove the stop rings and remove the pin, see fig. 101.
Remove the piston rings and clean the slot.
Measure diameter **Q** at height **A** from the base of skirt (A = 9 mm).
If the diameter is worn more than the 0.05 mm minimum given value, replace piston and rings.

Note: The provided oversize elements are of 0.50 mm and 1.00 mm

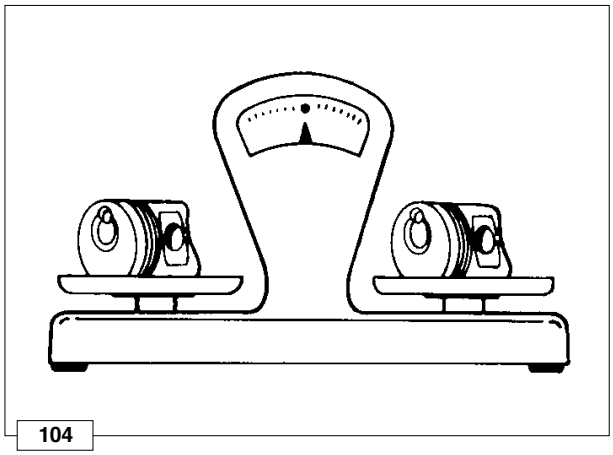
Piston, class

The pistons are subdivided according to their diameters into categories: **A**, **B**, **C**. These references, are shown on the top of the piston (see fig. 100).

~~LDW 502-602-903-1204-1204/T~~			
~~Class~~	~~Ø Cylinder - mm~~	~~Ø Piston - mm~~	~~Clearance - mm~~
~~A~~	~~71,990 : 72,000~~	~~71,930 : 71,940~~	~~0,050 : 0,070~~
~~B~~	~~72,000 : 72,010~~	~~71,940 : 71,950~~	
~~C~~	~~72,010 : 72,020~~	~~71,950 : 71,960~~	
LDW ~~702 - 100~~3 - 1404			
Class	**Ø Cylinder - mm**	**Ø Piston - mm**	**Clearance - mm**
A	74,990÷75,000	74,930÷74,940	0,050÷0,070
B	75,000÷75,010	74,940÷74,950	
C	75,010÷75,020	74,950÷74,960	

Piston supply:

Pistons at the nominal diameter are only supplied in category **A**.
Pistons oversized by 0.50 and 1.00 mm are supplied with reference to the increased level on the piston crown:
~~Ø 72.5 – Ø 73 for LDW 502-602-906-1204-1204/T engines and~~ Ø 75.5 – 76.0 for LDW ~~702-100~~3-1404 engines.

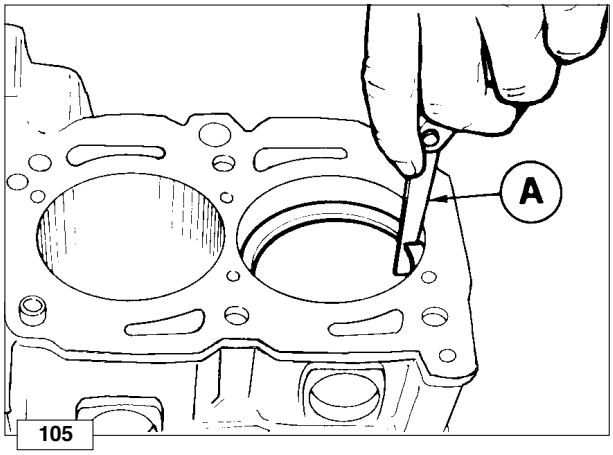


104

Piston, weight

Weigh pistons when replacing them in order to avoid unbalance.

Important
The difference in weight should not exceed 4 g.

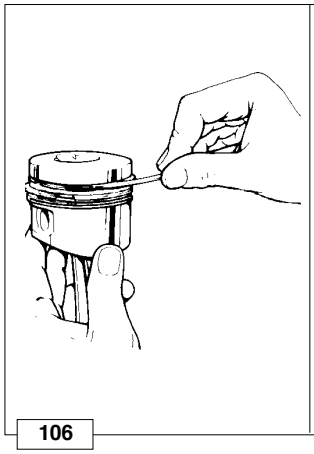


105

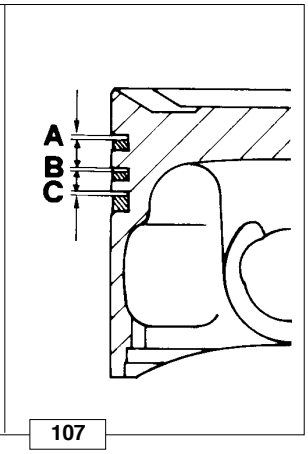
Piston rings - End gaps (mm)

Place piston rings squarely into the unworn part of the lower cylinder and measure the end gap **A**.

Piston ring	A	limit value
1°	0,25÷0,45	1.0
2°	0,25÷0.45	
3°	0,20÷0,45	



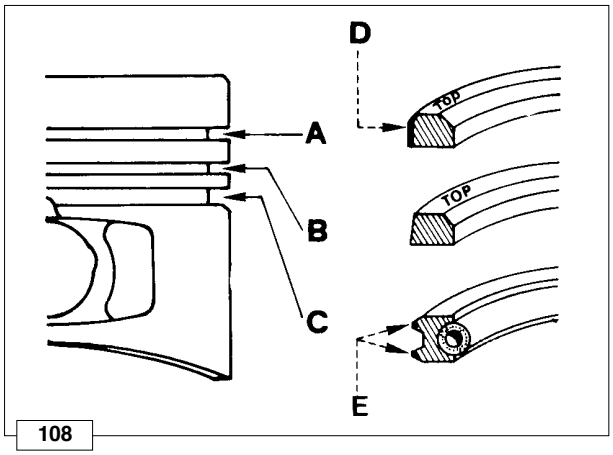
106



107

Piston ring, Clearance between grooves (mm)

A	0,090÷0,125
B	0.050÷0,085
C	0,040÷0,075

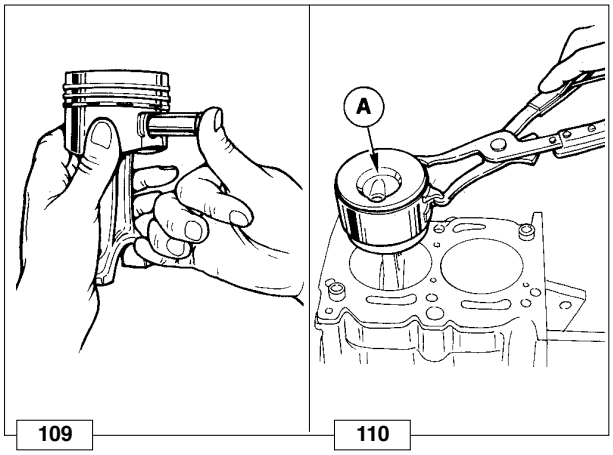


108

Piston ring, mounting order

A = 1° ring (internal tapered and torsional)
B = 2° ring (internal tapered and torsional)
C = 3° Oil control ring
D = Chrome-plated area
E = Chrome-plated area

Note: When there is writing on the surface of a piston ring, mount that surface with face upward.



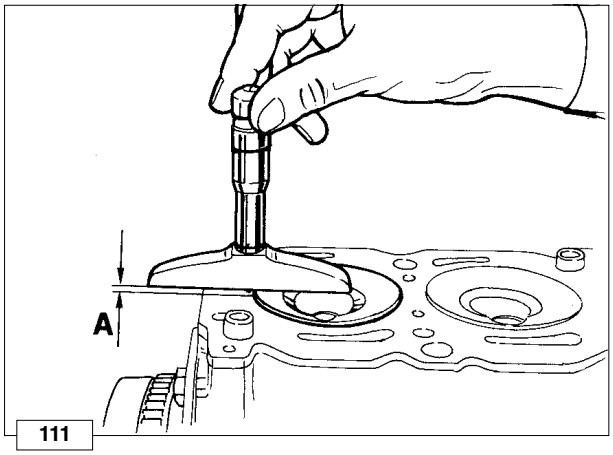
109 110

Piston, assembly

Important
Before re-mounting lubrificate the piston pin, piston, cylinder and conncecting rod big end bearing.

Couple the piston to the connecting rod inserting the pin, after lubricating it, just via thumb pressure.
Insert the two pin stop rings and check that they are properly housed in their seats, see fig. 101.
Using piston ring compression pliers, introduce the piston into the cylinder so that combustion chamber **A** is directly under the precombustion chamber parallel to the head.
Couple the piston/connecting rod to the crankshaft.

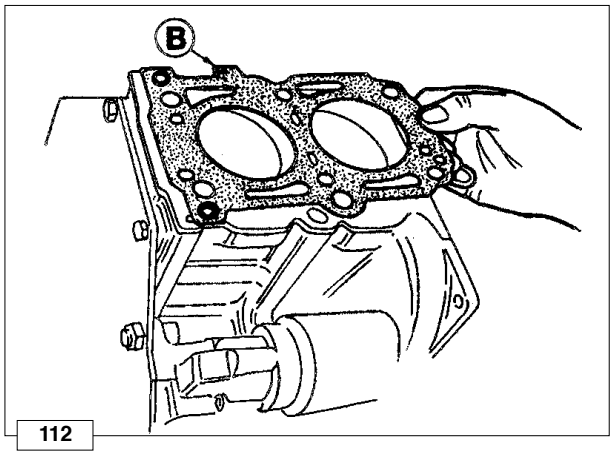
➲ For tightening the head/connecting rod see fig. 115-116.



111

Piston clearance

The piston in the TDC (top dead centre) position may extend or be short of the upper surface of the cylinder.
Determinare the clearance of each piston using a dial indicator to measure the difference between the two surfaces (piston crown and upper cylinder surface).
To determine the piston clearance and, by consequence, which copper gaske is most suitable it is necessary to consider the **A** value of the piston that projects furthest.



112

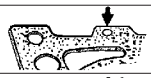
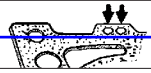
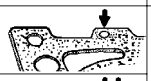
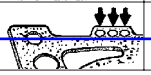
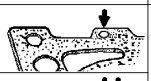
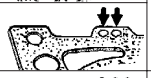
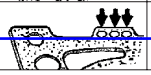
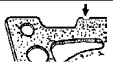
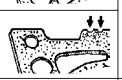
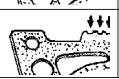
Head gasket

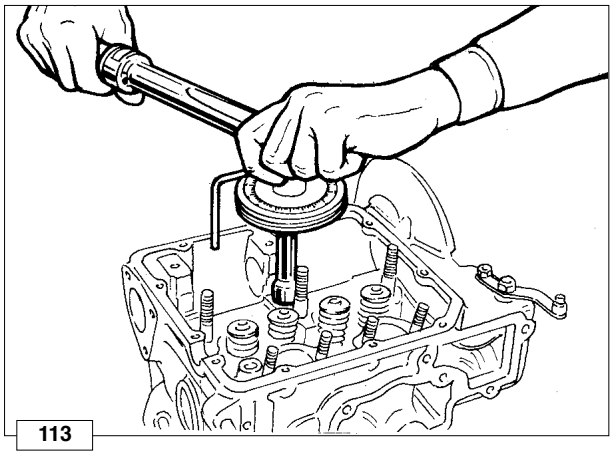
Important

Remove the cylinder head gasket seal from its protective covering only when you are going to mount it.

The gasket thickness is identified by the number of notches located in point **B**.

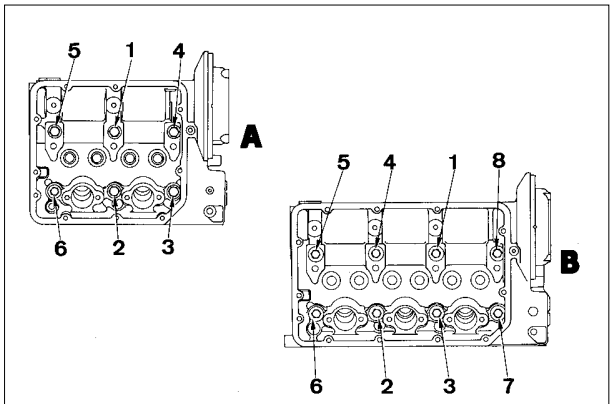
Choose the appropriate gasket considering that each A value on the table corresponds to a gasket with: no hole, one hole, two holes, or for the 1404 one notch, two notches, three notches.
The **A** value relates to figure 111.
Each time you dismount the head you must replace the gasket.

LDW 502 - 602 - 903		
A (mm)	N° of holes	Piston clearance
0.97 : 1.06	0 holes	0.39 : 0.48
1.07 : 1.16	1 hole 	
1.17 : 1.25	2 holes 	0.40 : 0.48
LDW 1204 - 1204/T		
A (mm)	N° of holes	Piston clearance
0.97 : 1.06	1 hole 	0.39 : 0.48
1.07 : 1.16	2 holes	
1.17 : 1.25	3 holes 	0.40 : 0.48
LDW 702 - 1003		
A (mm)	N° of holes	Piston clearance
0.82 : 0.91	1 hole 	0.54 : 0.63
0.90 : 1.01	2 holes 	
1.02 : 1.10	3 holes 	0.55 : 0.63
LDW 1404		
A (mm)	**N° of notches**	**Piston clearance**
0.82÷0.91	1 notch 	0.52÷0.61
0.92÷1.01	2 notches 	
1.02÷1.10	3 notches 	0.53÷0.61


113

Cylinder head assembly

Use a torque wrench equipped with a device for angular tightening.
Measure the length of each screw (normal length = 89.5÷90.5 mm).
Replace it if it exceeds 92 mm.
Proceed as follows.



114

~~Cylinder head tightening procedure LDW 502-602-702-903-1003~~

~~Important~~
~~Once the head has been correctly tightened, it should not be retightened except if it is disassembled again.~~
~~Before mounting it is advisable to lubricate stem, shank and underhead of screws with SPARTAN SAE 460 oil.~~

~~A~~ ~~= For LDW 502-602-702 models~~
~~B~~ ~~= For LDW 903-1003 models~~

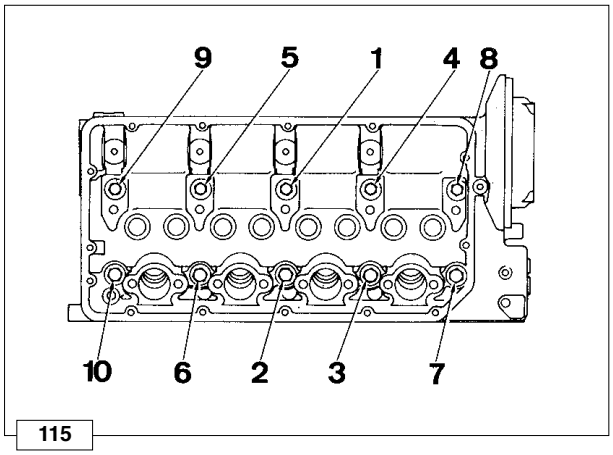
~~Following the numerical order shown in the diagram, the bolts must be tightened in three phases:~~

~~**1st** phase = 50 Nm~~
~~**2nd** phase = Rotate the wrench 90° in a clockwise direction.~~
~~**3rd** phase = Rotate the wrench again 90° in a clockwise direction.~~

~~For LDW 502 with pressure cast (aluminium) crankcase:~~

~~With head **H** tightening bolts: **1st** phase = 60 Nm~~

~~With head **8.8** tightening bolts: **1st** phase = 40 Nm~~
~~**2nd** phase = Eseguire una rotazione della chiave in senso orario di 90°.~~
~~**3rd** phase = Proseguire con una rotazione della chiave in senso orario di 90°.~~

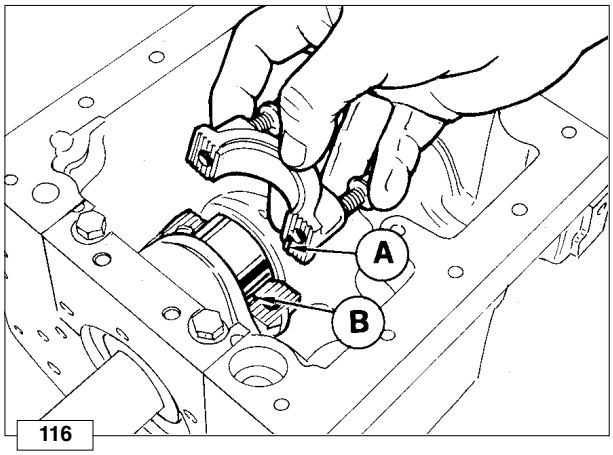


115

Cylinder head tightening procedure LDW ~~1204-1204/T-~~1404

Following the numerical order shown in the diagram, the bolts must be tightened in three phases:

1st phase = 50 Nm
2nd phase = Rotate the wrench 90° in a clockwise direction.
3rd phase = Rotate the wrench again 90° in a clockwise direction.



116

CONNECTING ROD

Caution – Warning

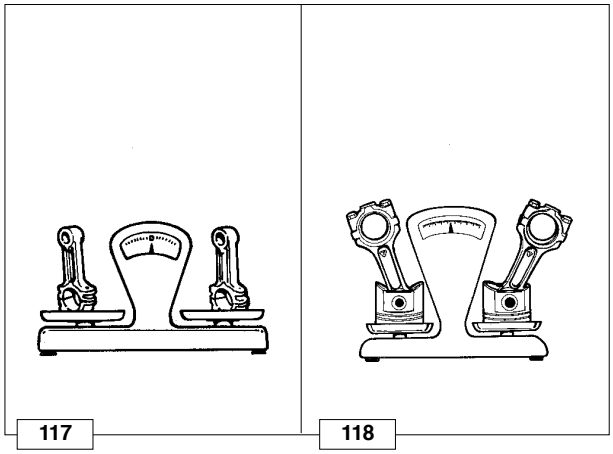
While reassembling the big end bearings, we suggest cleaning all parts thoroughly, as well as proper greasing in order to avoid risks of seizure at the first start.

Big end bearing

After connecting rod from crankshaft disconnection, check the following.
While reassembling, be sure the two centring notches **A** an **B** are on the same side.

❍ Tighten the connecting rod big end cap screws simultaneously at a torque of 40 Nm.

Note: The big end bearing is supplied both at the nominal value and undersized by 0.25 and 0.50 mm.
~~In the LDW 502 engine with light alloy crankcase the connecting rod is aluminium type and not provided with connecting rod big end bearing and small end bush.~~


117 118

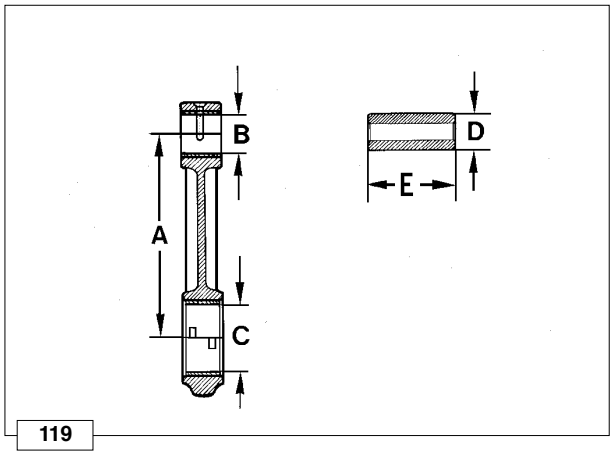
Connecting tod, weight

Weigh connecting rods when replacing them in order to avoid unbalance.

Important

The difference in weight should not exceed 10 g.

The difference in weight of the pre-assembled connecting rod, piston and pin must not exceed 14 g.

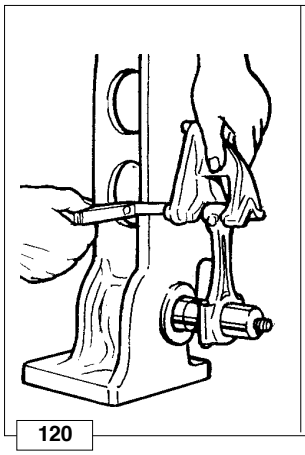


119

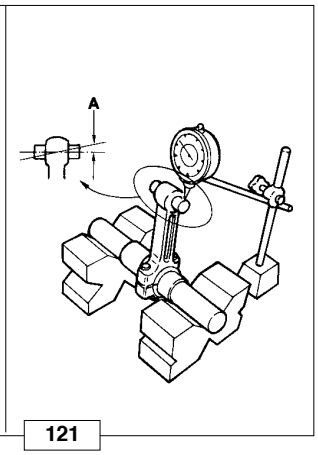
Connecting rod with bearings and pin

Dimensions (mm):
A = 126,48÷126,52
~~= 106,98 : 107,02 ..... (for LDW 502)~~
B ~~= 18,015 : 18,025~~
= 20,015÷20,025 ..... (for LDW ~~702-1003-1204/T-~~1404)
C = 40,021÷40,050 ..... (bearing tightened at 40 Nm)
D ~~= 17,996 : 18,000~~
= 19,996÷20,000 ..... (for LDW ~~702-1003-1204/~~T-1404)
E ~~= 50,900 : 51,100~~
= 54,000÷55,100 ..... (for LDW ~~702-1003-1204/T-~~1404)
(B-D) = 0,015÷0,039 **(B-D)** limit value = 0,060

Nota: When driving the small end bearing make sure both oilholes are aligned.



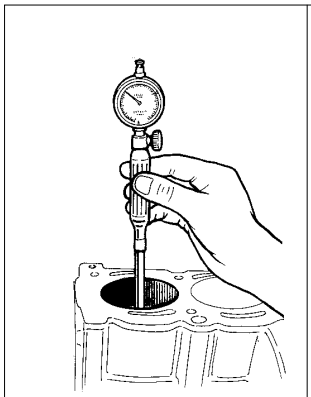
120



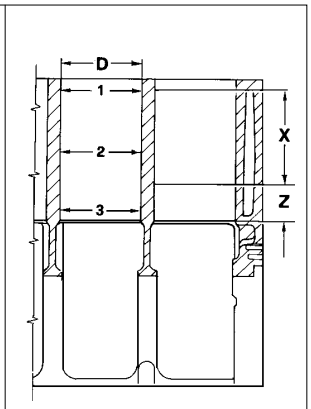
121

Connecting rod alignment

Utilizzare un calibro con piano di riscontro o un comparatore come in figura.
Controllare l'allineamento degli assi utilizzando lo spinotto del pistone; lo scarto **A** = 0,015 mm;. limite 0,030 mm.
Piccole deformazioni si possono correggere sotto una pressa agendo con sforzi graduali.



122

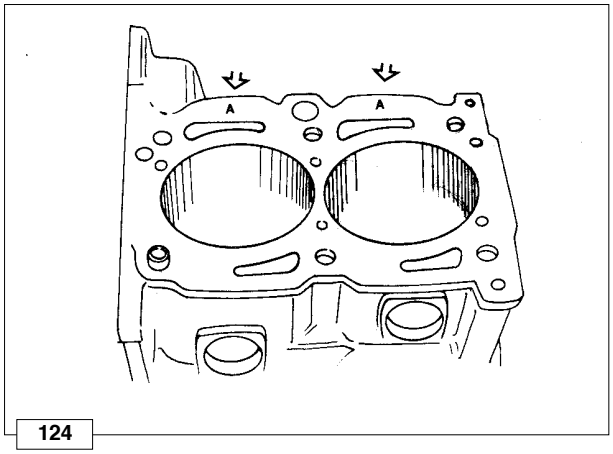


123

CYLINDERS

Reset the dial gauge with a calibrated ring: check the diameter **D** in points **1**, **2** and **3**; repeat the same operation rotating the dial gauge by 90° at the same heights.
Check any wear in zone **X** where the piston rings operate and if it is greater than the 0.05 mm max limit given adjust the cylinder to the next increased value.

~~72,000 mm for LDW 502-602-903-1204-1204/T engines;~~
75,000 mm for LDW ~~702-1003~~-1404 engines.

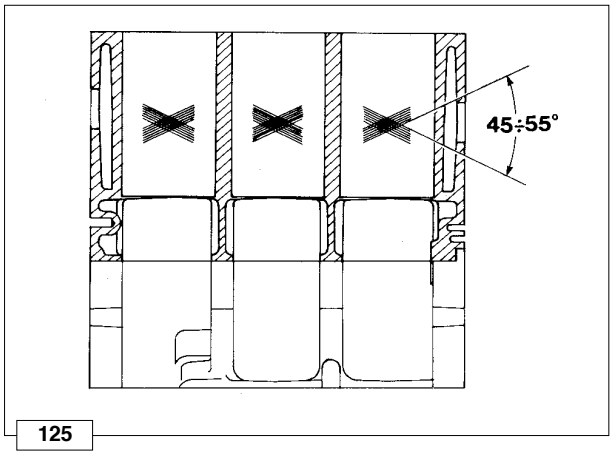


124

Cylinder, class

The pistons (**A**, **B**, **C**) locations are shown on the piston crown while those for the cylinders are found on the crankcase in the points shown by the arrows, see picture.

Note: ~~For LDW 502 with an aluminium crankcase, the cast iron cylinders can be adjusted normally to increase values by 0.5 and 1.0 mm~~.
The cylinders are not to be changed.

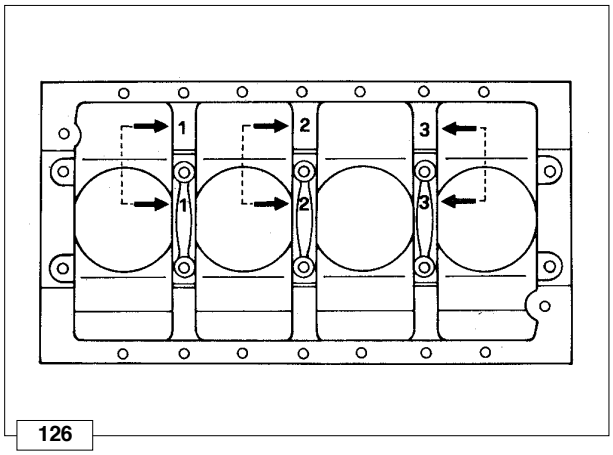


125

Cylinder roughness

Caution – Warning
Do not treat the cylinder's internal surfaces with an emery cloth.

The angle of the crossed processing marks must be between 45° and 55°. These must be uniform and distinct in both directions.
Average roughness must be between 0.5 and 1 μm.
The whole surface of the cylinder affected by contact with the piston rings must be rendered with the plateau method.

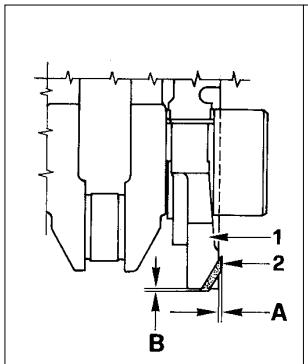


126

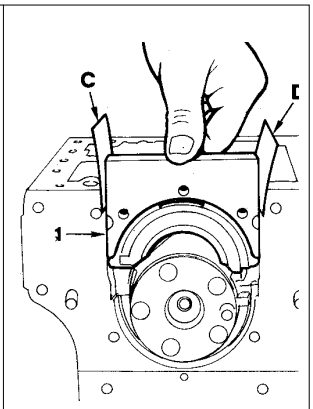
Central main bearing caps

The central support caps are marked with locations that can be numbers as in the diagram or dots.
The same locations are given on the crankcase.
Couple the caps with the same references and on the same side. In any case locate the bearing's two centring notches that are to be found on the same side.

❍ Tighten the screws simultaneously at a torque of 60 Nm.



127



128

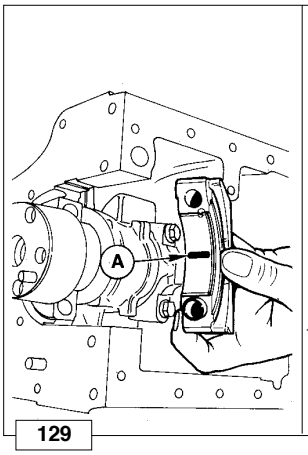
Rear and forward main bearing caps

Important
Before the final tightening, check the coplanarity of the two levels with a ground bar

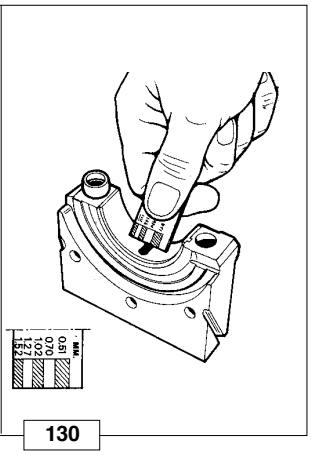
On remounting the rear main bearing cap **1** replace the lateral rubber gaskets **2**, keeping in mind that projections **A** and **B** of the support must be 0,5÷1,0 mm; cut off any exceeding portions.
Do the same with the front bearing cap.
Before reintroducing the bearings in the crankcase, place between their surfaces two plates **C** and **D** - 0.1 mm thick - se.no.7107-1460-053.

❍ Tighten the screws at a torque of 60 Nm.

Note: It is advisable to apply a few drops of silicon sealant on the surface of the gasket slot **2**.



129



130

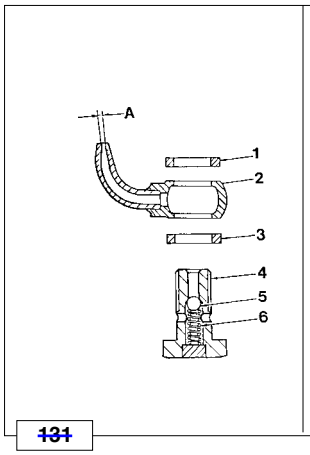
Check the clearances between the bearings and the journal

Use the "Perfect Circle Plastigage" type calibrated wire **A** and put it at the centre of the bearing with a bit of grease.

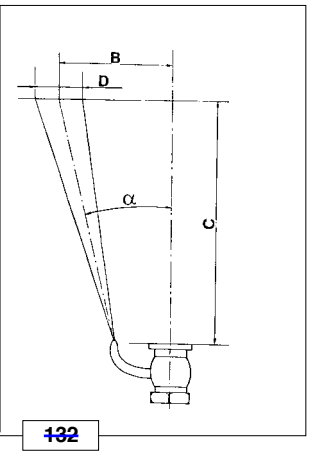
❍ Tighten the screws at a torque of 60 Nm.

Find out the clearance value checking the wire's compression with the appropriate graduated scale supplied in the same pack and available on the market.

➲ For clearance values between the journals, connecting rod pin and the relevant bearings see page 64.



131



132

Piston coolant nozzles

Caution – Warning

The piston has a recess so that during up-down movements and vice versa it cannot come into contact with the nozzle. When remounting the nozzle be careful that it is placed so that when the piston goes past it is in the centre of the recess.

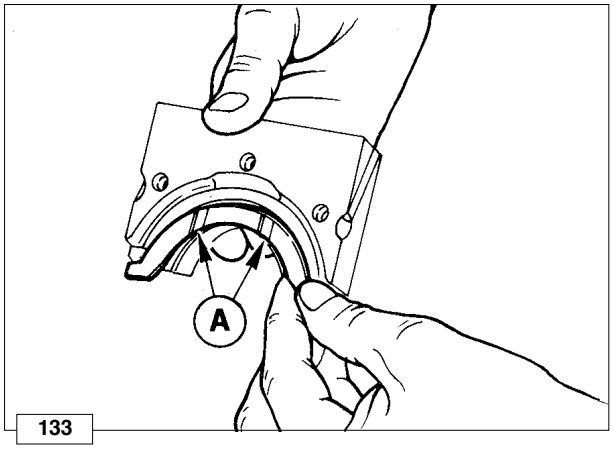
They are in the supercharged LDW 1204/T engine and are housed near the main bearings.

Components:

1 Washer
2 Nozzle
3 Washer
4 Joint (tighten to 12Nm)
5 Valve (opening pressure = 1 : 1.2 bar)
6 Spring

Characteristics (mm):

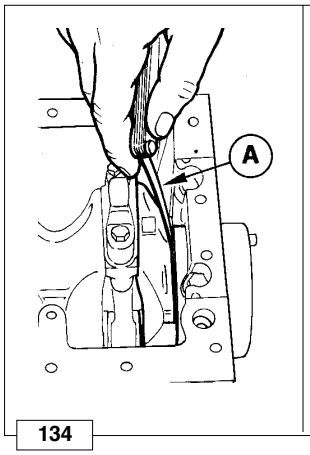
A	B	C	D	α
0,80 : 0,85	34	150	16	5°



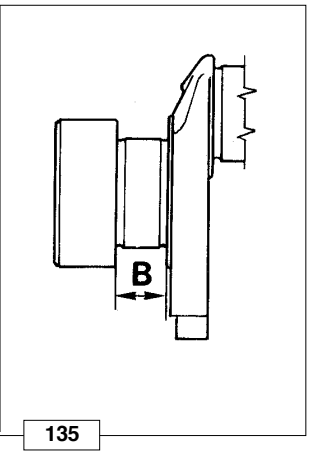
133

Shoulder half rings

So as to keep them in their seats during assembly, put a bit of grease.
The half-rings must be assembled with the slots **A** as in the figure.
Thickness of half-rings is equal to 2.31÷2.36 mm.
They are supplied as spare parts as increased thickness 0.1 and 0.2 mm, see below.



134



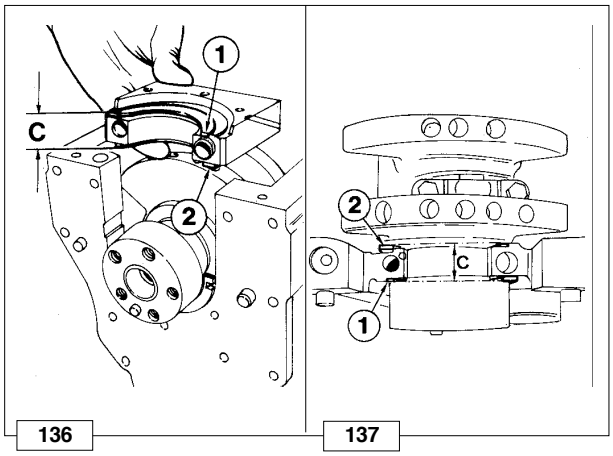
135

Crankshaft axial clearance

After tightening the main bearings measure the axial clearance **A** between the crankshaft flywheel side shoulder and the main bearing half rings.

Ref.	*Clearance*	*Limit value*
A mm	0,130÷0,313	0,5
B mm	23,05÷23,10	23,50

If the clearance is not within the given value check value **B**.
If need be, fit oversized half rings, see below.



136 137

Shoulder half rings, oversized elements

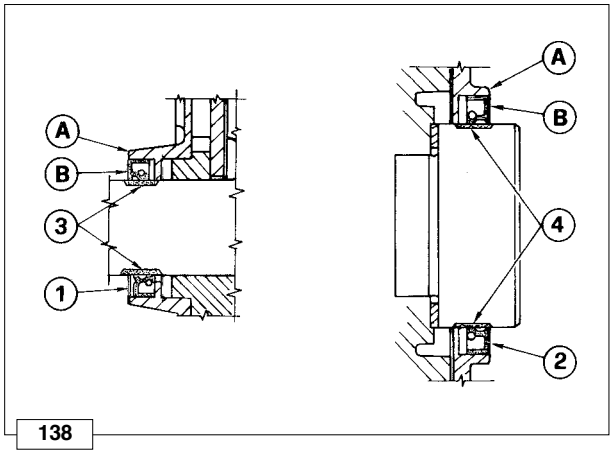
Dimensions (mm):

	C	B**	A*
Std	22,787÷22,920	23,050÷23,100	0,130÷0,313
1ª	22,987÷23,120	23,250÷23,300	
2ª	3,087÷23,220	23,350÷23,400	
3ª	23,187÷23,320	23,450÷23,500	

* **A** of Fig. 134.
** **B** of Fig. 135.

Grinding **B** as per relevant table, you can mount the following half rings:

1st Oversized element Half rings **1** and **2** + 0.10 mm on both sides of the bearing
2nd Oversized element Half rings 1 and 2 + 0.10 mm on one side of the support and + 0.20 mm on the other side.
3rd Oversized element Half rings 1 and 2 + 0.20 mm on both sides of the bearing.



138

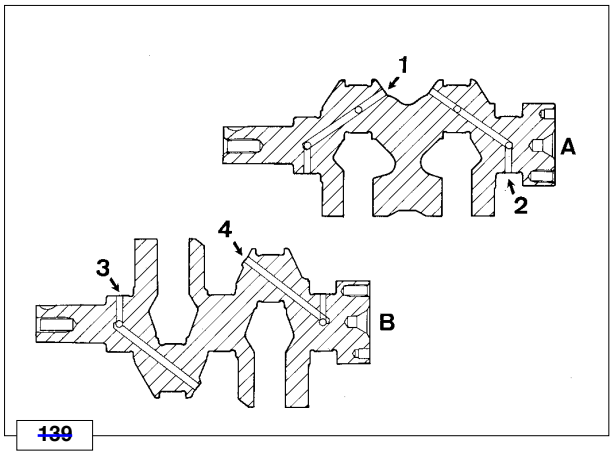
Crankshaft front and back oil seal rings

Caution – Warning
An ambient temperature below -35°C may damage the rings.

The front oil seal ring **1** inserted into the oil pump cover and the back one **2**, in the flywheel side flange.
If warped, hardened, or cracked, replace them.

For the replacement:
- Carefully clean the housing
- Keep the ring immersed in engine oil for about half an hour.
- Drive it into its housing with a buffer exercising a uniform pressure on the whole front surface. Be sure that the two surfaces **A** and **B** meet on the same level.
- Refill the interior hollow with grease and lubricate the seal lip with thickened oil.

Note: Before major engine overhaul, in case of oil leakage in the seal area of rings **3** and **4**, you can remedy this by replacing the rings and pushing them about 2 mm deeper with respect to the previous ones.
If the rings are black it means zones **3** and **4** of the crankshaft are tempered. In this case it is necessary to remount a ring of the same colour.
If the rings are brown it means that zones **3** and **4** of the crankshaft are not tempered. In this case it is necessary to remount brown coloured rings.



139

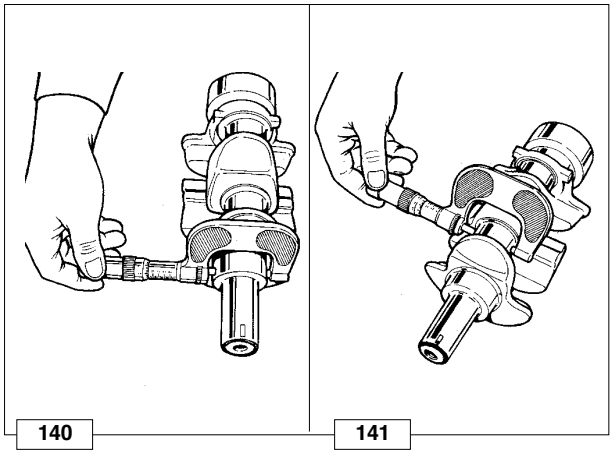
Crankshaft, lubrication lines

Caution – Warning
During repairs, when compressed air is used it is important to wear protective goggles.

A = Crankshaft LDW 502
B = Crankshaft LDW 602-702

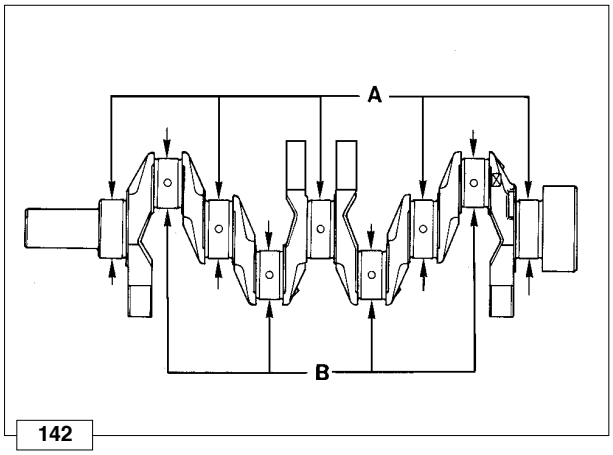
Put the crankshaft in a bath of crude oil.
Remove the caps and clean lines **1** and **2** or **3** and **4** with a bit; blow with compressed air.
Reposition the new caps in their seating and check the seal.

Note: The LDW 502 crankshaft with aluminium crankcase is not interchangeable with the cast iron crankcase, having different counterweights.


140 141

Crankshaft, check journals and crank

Use a micrometer for the outsides.

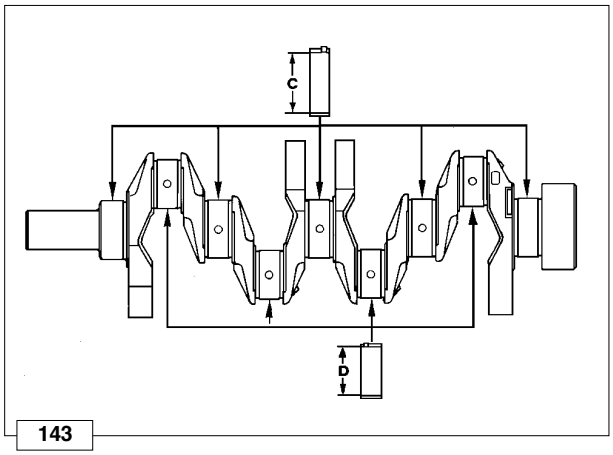


142

Journal and connecting rod pins diameters

Dimensions (mm):

LDW 502 - 602 - 903 - 1204 - 1204/T		
Ref.	**Tolerance**	**Limit value**
A (mm)	47,984 : 48,000	47,900
B (mm)	39,984 : 40.000	39,900
LDW 702 - 1003 - 1404		
Ref.	**Tolerance**	**Limit value**
A (mm)	50,981÷51,000	50,900
B (mm)	39,984÷40.000	39,900



143

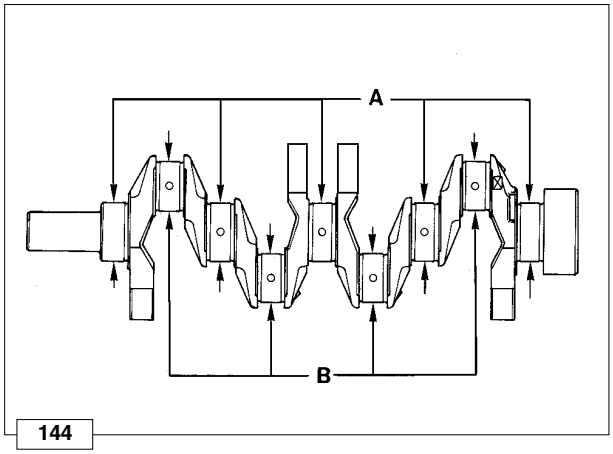
Main bearings and connecting rod big ends diameters

Dimensions (mm):

~~LDW 502 - 602 - 903 - 1204 - 1204/T~~		
~~Ref.~~	~~Tolerance~~	
~~C (mm)~~	~~48,016 : 47,984~~	~~48,055~~
~~D (mm)~~	~~40,021 : 40,050~~	~~40,100~~
LDW ~~702 - 1003~~ - 1404		
Ref.	**Tolerance**	
C (mm)	51,023÷51,059	51,098
D (mm)	40,021÷40,050	40,100

The dimensions given refer to tightened bearings.

➲ For tightening torque see figures 116 e 126.



144

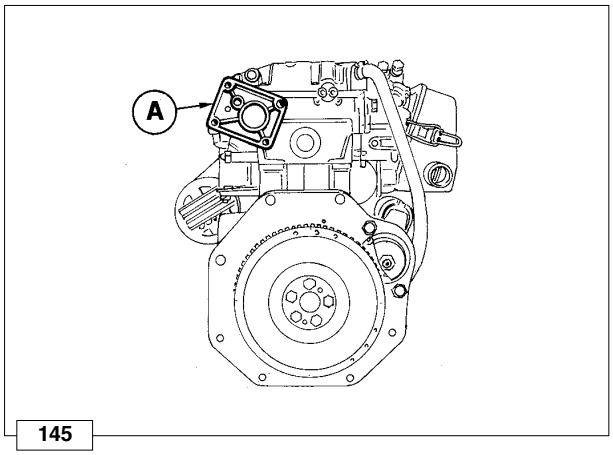
Clearances between the bearings and corresponding pins

See figures. 143 ÷ 144.

Dimensions (mm):

~~LDW 502 - 602 - 903 - 1204 - 1204/T~~		
~~*Ref.*~~	~~*Clearance*~~	~~*Limit value*~~
~~C-A (mm)~~	~~0,022 : 0,074~~	~~0,200~~
~~D-B (mm)~~	~~0,021 : 0,066~~	~~0,130~~
LDW ~~702 - 1003~~ - 1404		
Ref.	***Clearance***	***Limit value***
C-A (mm)	0,023÷0,078	0,200
D-B (mm)	0,021÷0,066	0,130

Nota: Both for crankshaft bearings and for connecting rod big end bearings internal diameter are undersized by 0.25 and 0.50 mm.

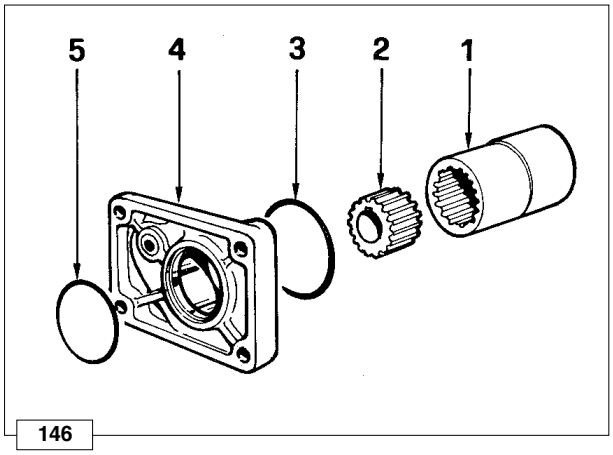


145

Hydraulic pump drive

A = Third drive

You can mount a 2P hydraulic pump on the third drive with Bosch flanging, or a 1 PD type one.
You can draw 7 KW of power from the third drive corresponding to a 37 Nm torque at 3600 rpm (engine revolutions).
Drive ratio, engine revs/pump revs = 1:0.5.



146

Third drive, components

1 Splined sleeve
2 Toothed pinion
3 Seal ring
4 Flange for 1 PD hydraulic pump
5 Seal ring

Note: Sleeve **1** also includes the fuel pump control cam and is fastened with the same standard cam screw, with a tightening torque of 80 Nm + 90°.

❍ Tighten pinion 2 to the hydraulic pump at 45 Nm

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

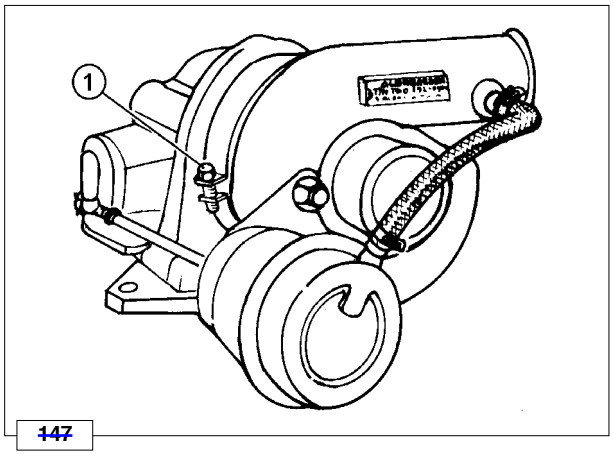
. .....

. .....

. .....

. .....

. .....

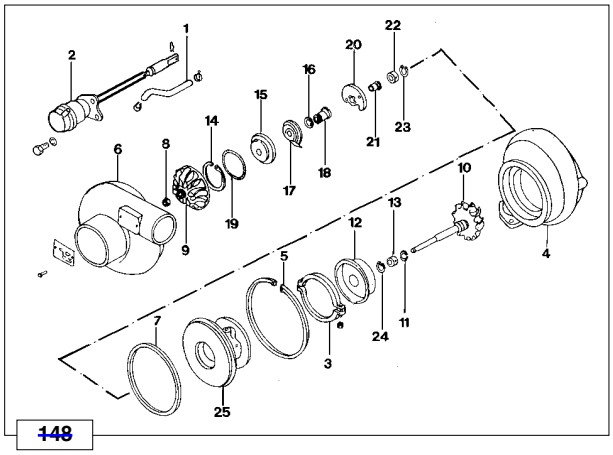


147

TURBO CHARGER

Only the LDW 1204/T is supplied with the turbocharger.
The LDW 1204/T is available in two versions:

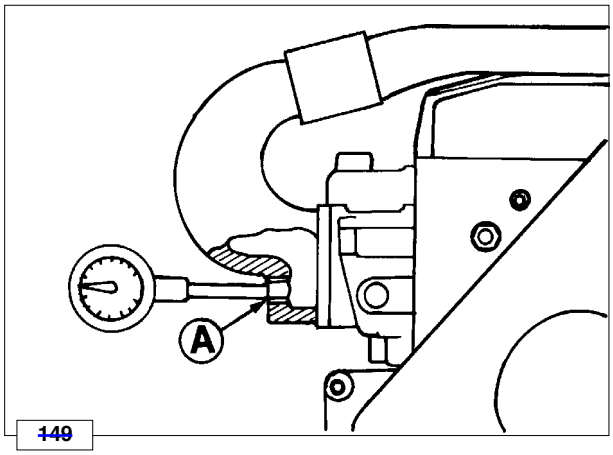
TD 025 03C 2.8 for 3600 r/min
TD 025 03C 2.0 for 3000 r/min.



148

Turbocharger components

1 Waste gate tube
2 Attuatore
3 Collare
4 Corpo turbina
5 Anello seeger
6 Chiocciola compressore
7 Spessore
8 Dado
9 Controdado
10 Albero con turbina
11 Segmento
12 Parafiamma
13 Cuscinetto
14 Seeger
15 Spessore
16 Segmento
17 Deflettore olio
18 Manicotto reggispinta
19 O-ring
20 Cuscinetto reggispinta
21 Anello reggispinta
22 Cuscinetto
23 Anello seeger
24 Anello seeger
25 Supporto cuscinetti



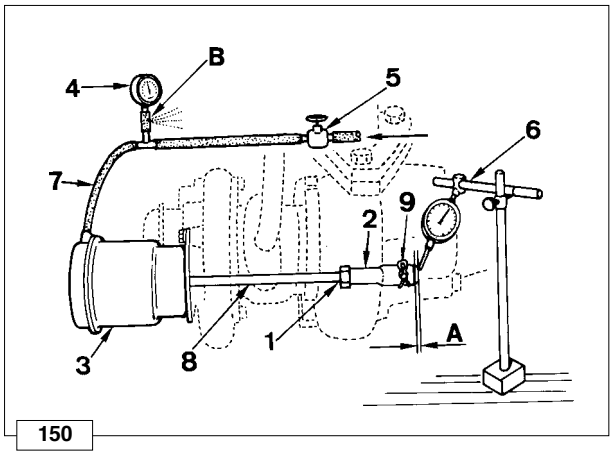
149

Turbocharger pressure testing

Install a 0-2bar pressure gauge at position **A** after removing the existing plug.
Start the engine and operate at low idle for five minutes to allow warm up.
Increase the engine speed to 3000 r/min or 3600 r/min (depending on engine specification while applying full Nb load to the engine).

➲ See page 10 for the power output curve.

The gauge pressure, at full speed, full load, should be 0.87-0.91 bar (655÷685 mm Hg).
If the pressure setting does not reach specification, adjust the turbocharger waste gate **8** as is defined on page 48.



150

Turbocharger west gate adjustment - Regolazione corsa asta comando valvola " Waste gate "

Disconnect westgate tube **7** from the turbocharger compressor side.
Using a T-joint connect a pressure gauge **4** (scale 0 to 2 bar) and with the compressed air network pipe complete with reducer **5**.
The network air supply pressure must be from 1.5 to 2 bar.
Make a hole **B** in the pressure gauge pipe of 1.55 mm in diameter.
This will help bleeding some air and stabilizing pressure in the pressure gauge.
Set up a dial gauge (**6**) so that the feeler is rested on terminal **2**.
Via the pressure reducer 5 convey some air to the actuator so as terminal **2** is pushed forwards by **A** (A=1 mm).
The pressure read in the pressure gauge must be 830÷890 mm Hg (1.11÷1.19 bar).
If the pressure is lower than the given value proceed as follows.
Unscrew locknut **1**.
Remove split pin **9** and disconnect rod **8**, "waste gate" control valve.
Keeping the rod steady tighten terminal **2** until you reach the calibration pressure.
During the rotation of terminal **2**, the rod should not undergo any torsion.

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

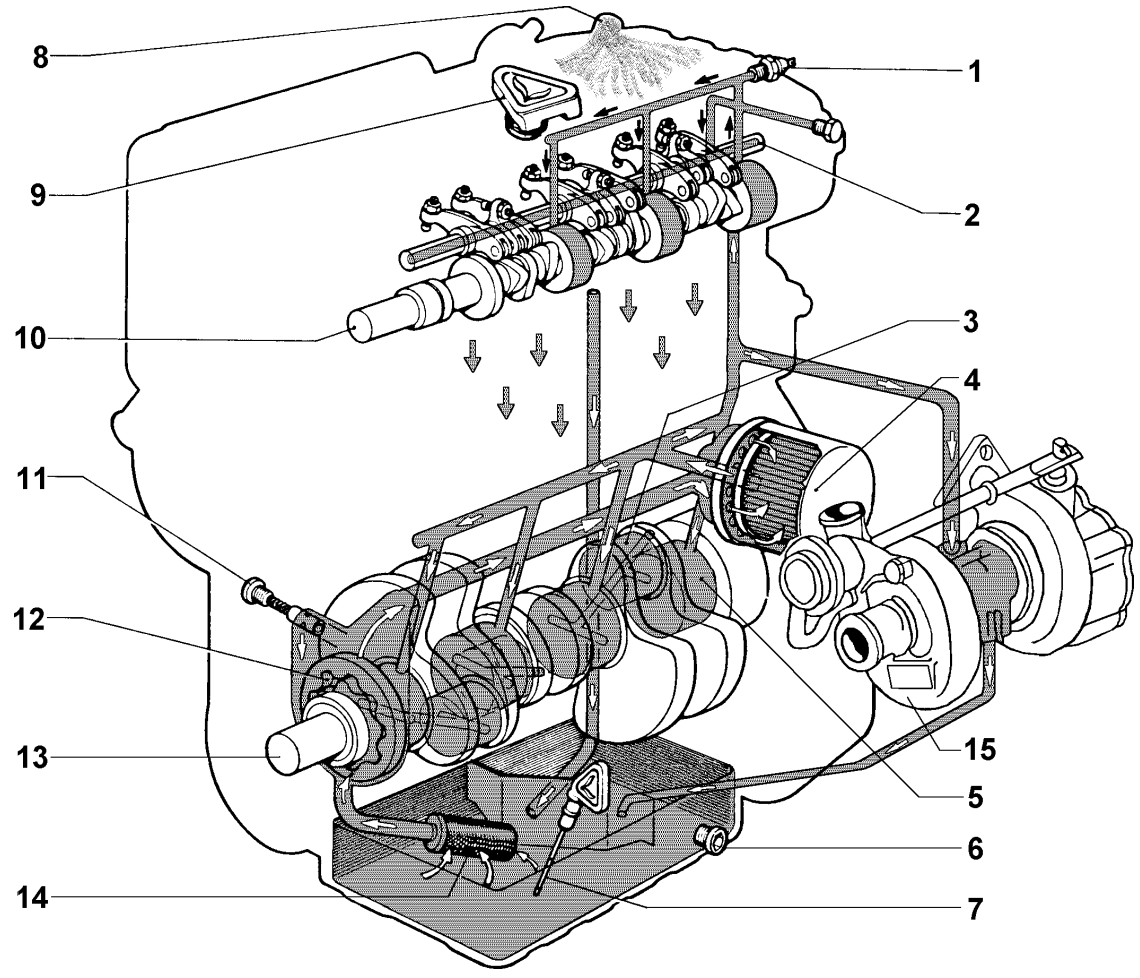
Danger – Attention

- **The engine can be damaged if allowed to operate with insufficient oil. It is also dangerous to add too much oil because its combustion may lead to a sharp increase in the rotation speed.**
- **Use suitable oil in order to protect the engine.**
  Nothing more than lubrication oil can influence the performances and life of an engine.
- **Use of an inferior quality oil or failure to regularly change the oil will increase the risk of piston seizure, will cause the piston rings to jam and will lead to rapid wear on the cylinder liner, the bearings and all other moving parts. Engine life will also be notably reduced.**
- **The oil viscosity must suit the ambient temperature in which the engine operates.**

Danger – Attention

- **Old engine oil can cause skin cancer if repeatedly left in contact with the skin and for long periods of time.**
  Wear protective gloves to avoid touching used oil.
- **If contact with the oil is unavoidable, you are advised to wash your hands with soap and water as soon as possible.**
  Dispose of old oil in the correct way as it is highly polluting.

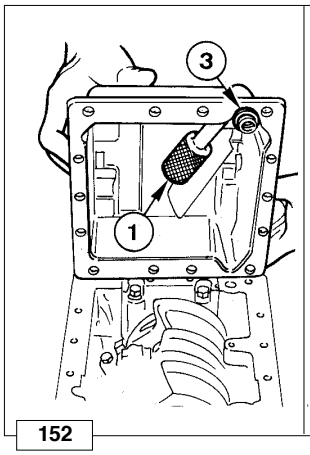
LUBRIFICATION CIRCUIT



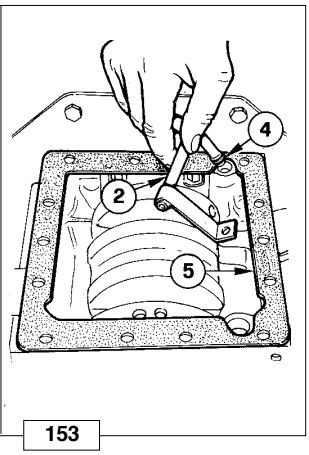
151

Components:

1 Pressure gauge
2 Rocker shaft
3 Connecting rod pin
4 Oil filter cartridge
5 Journal
6 Oil drain plug
7 Oil dipstick
8 Bleed
9 Oil filler cap
10 Camshaft
11 Oil pressure regulating valve
12 Oil pump
13 Crankshaft
14 Oil suction filter
15 Turbosupercharger with corresponding pipes only fitted in LDW 1204/T models.



152

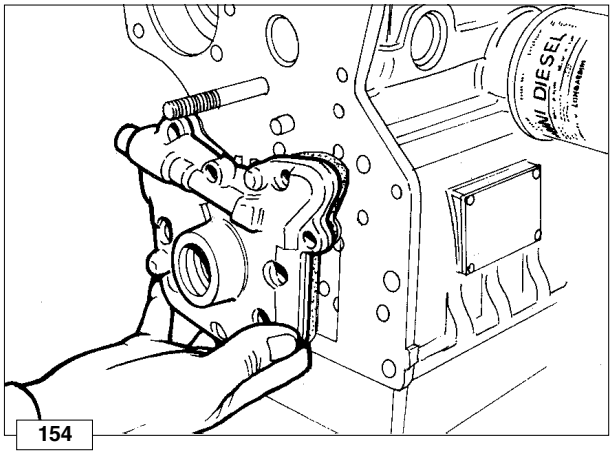


153

Internal oil filter and oil sump return pipe

Clean with petrol the internal oil filter **1** and oil sump return pipe **2**, blow also some compressed air.
Replace sealing rings **3** and **4**.

❍ Tighten oil drain plug at a torque of 40 Nm.



154

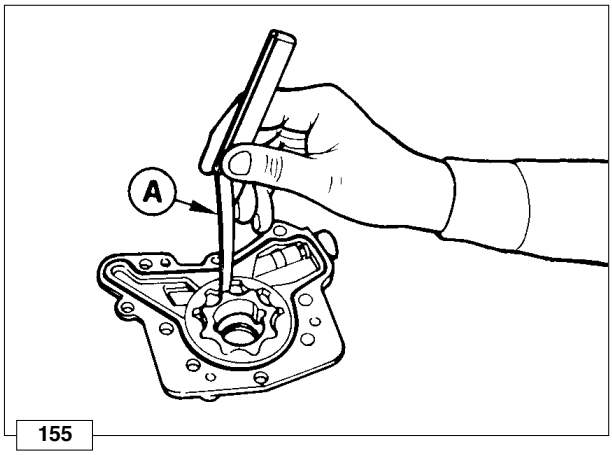
Oil pump

~~The oil pump mounted on LDW 502-602-903 engines has a lower delivery rate than that mounted on LDW 1204-1204/T engines~~.
Oil pump delivery test at 1000 revs per minute with an oil temperature of 120°C.

Engine	Delivery (l/1')	Pressure (bar)
5~~02-602-702-903-1003~~	~~4 : 4,~~3	3÷3,5
1~~204-1204/~~T-1404	6÷6,5	

Delivery test at 3600 rpm with an oil temperature of 120°C.

Engine	Delivery (l/1')	Pressure (bar)
5~~02-602-702-903-1003~~	~~19,~~3	4÷4,5
1~~204-1204/T-~~1404	28,5	

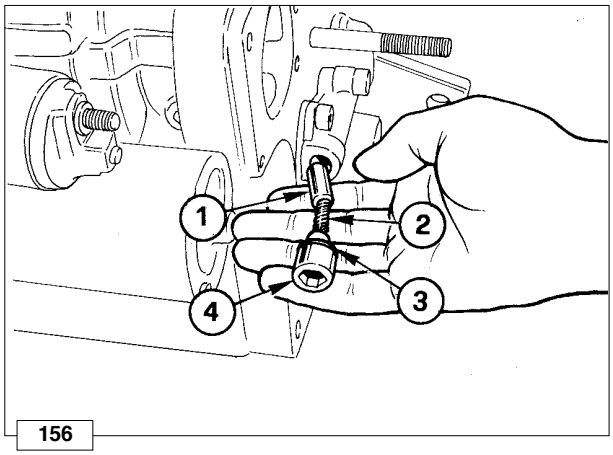


155

Oil pump, clearance between rotors

Measure the clearance **A** between teeth as in figure; the maximum value is 0.171 mm.
Clearance wear limit should be 0.250 mm.

➲ See page 42 for assembly and disassembly.



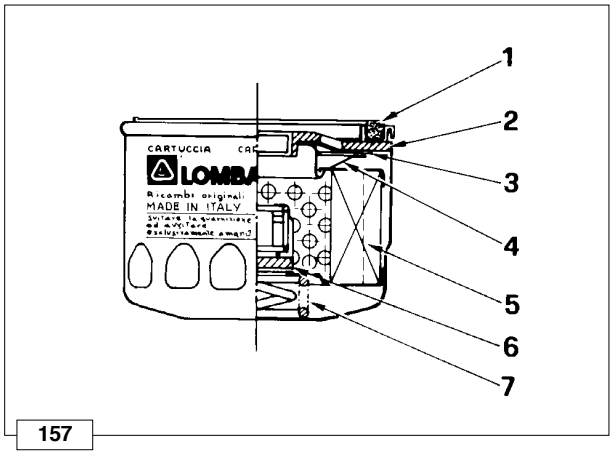
156

Oil pressure regulating valve

Components:
1 Valve
2 Spring
3 Gasket
4 Screw cap

Spring length = 27.50÷27.75 mm
Blow the valve's seating with compressed air and carefully clean all the components before remounting them.

Nota: The valve begins to open at a pressure of 4.5÷5.5 bar.



157

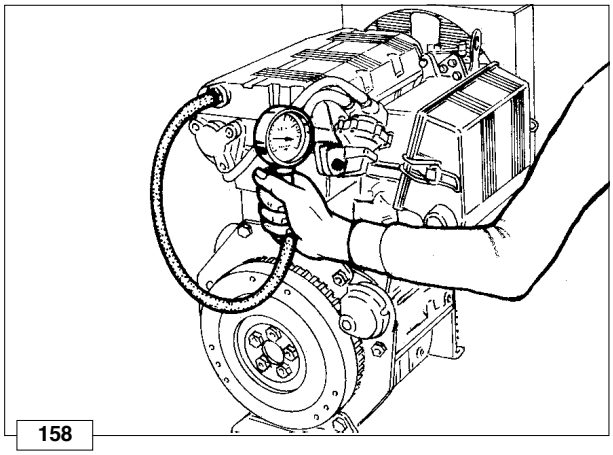
Oil filter cartridge

Components:

1 Gasket
2 Plate
3 Rubber element
4 Spring
5 Filtering element
6 By-pass valve
7 Spring

Characteristics:

Maximum operating pressure: ..... 7 bar
Maximum bursting pressure: ..... 20 bar
Degree of filtration: ..... 15 µ
By-pass valve calibration: ..... 1,5÷1,7 bar
Total filtration surface: ..... 730 cm^2
Total filtration surface for LDW 1204 engine: ..... 1450 cm^2.



158

Oil pressure check

Once remounted fill the engine with oil, fuel and coolant.
Remove the pressure switch, fit a union and connect a 10 bar pressure gauge.
Start the engine and check how pressure is affected by oil temperature.

Nota: With a maximum operating temperature of 120°C at 900 rpm the oil pressure must not be less than 1 bar.

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

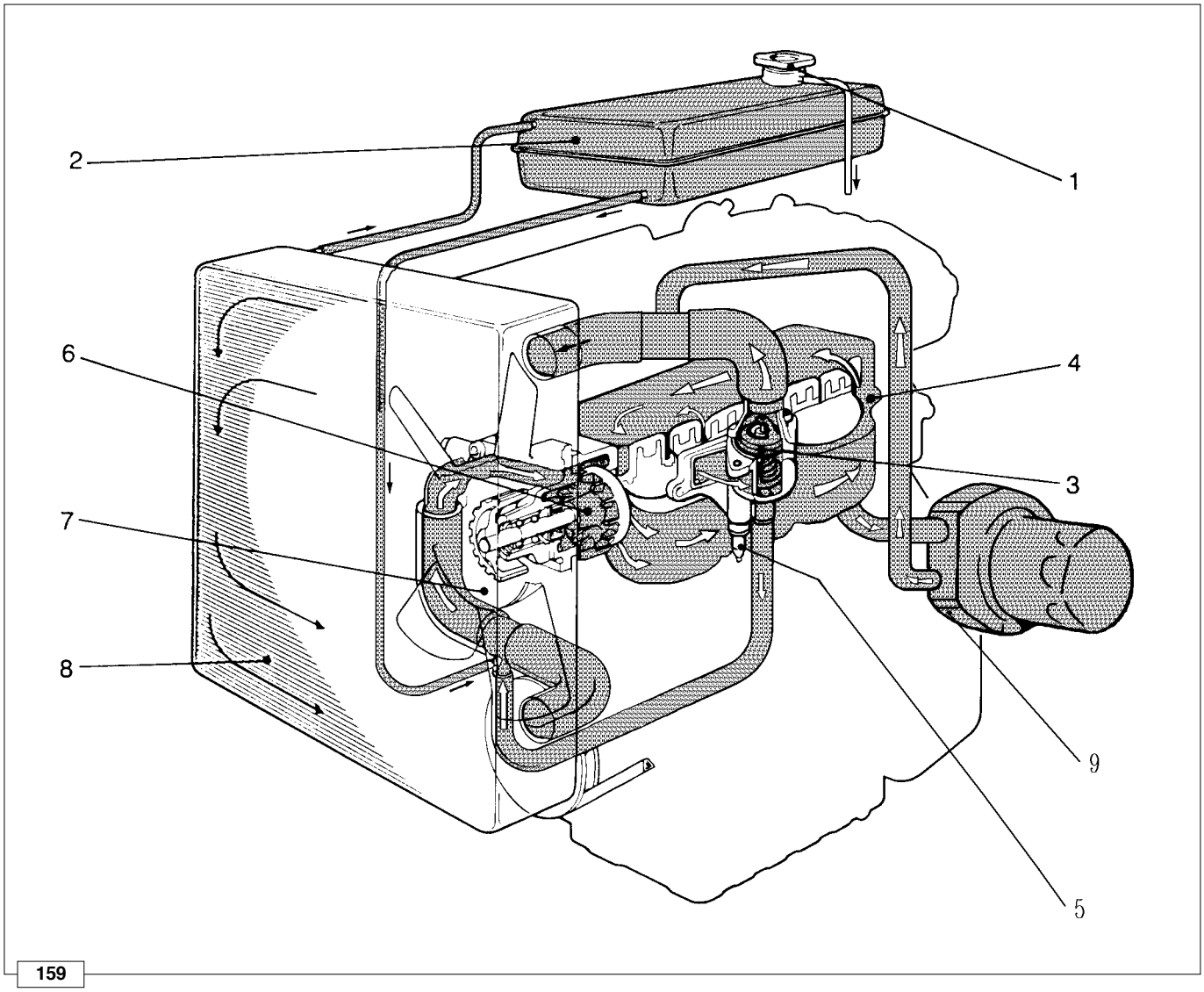
. .....

. .....

Danger – Attention

- **The coolant circuit is pressurised. Do not check it before the engine has cooled down and, also in that case, open the radiator cap or expansion tank plug with caution.**
- **When there is an electric fan do not approach a hot engine because it could also come on with the engine off.**
- **The liquid coolant is a pollutant and therefore must be disposed of with care according to environmental provisions.**

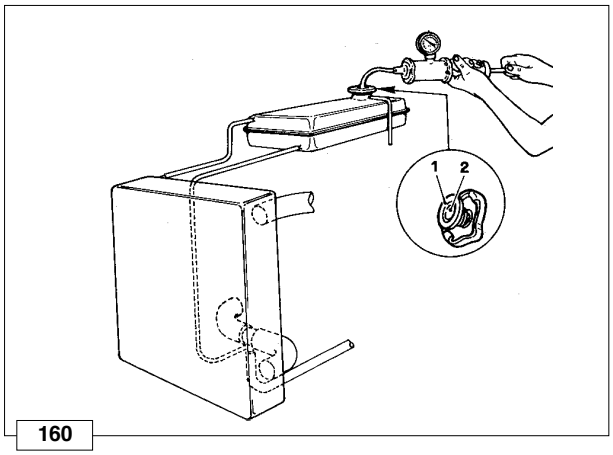
COOLANT CIRCUIT



159

Components:

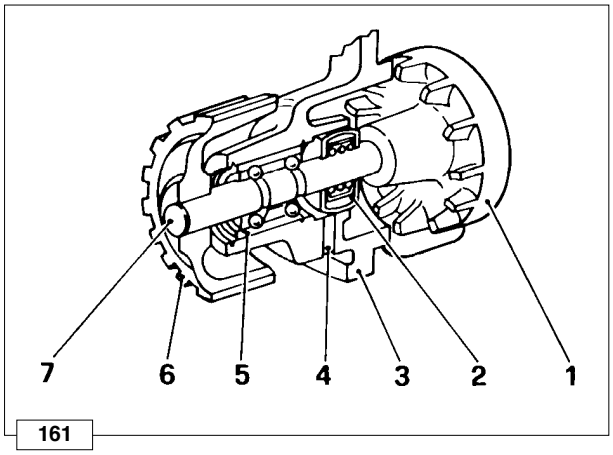
1) Coolant filler plug
2) Compensating tank
3) Thermostatic valve
4) Cylinder block
5) Thermostat for liquid temperature indicator
6) Circulation pump
7) Fan
8) Radiator
9) Heat exchanger with relevant pipes. Only fitted in LDW 1204/T engine.



160

Radiator and compensation, check and seal tank cap.

Remove the cap from compensation tank cap and check that the liquid is at the correct level.
Replace the cap with a new one provided with hand air pump socket.
Compress air at a pressure of 1 bar for about two minutes.
Check that there are no drips in the radiator.
The tank cap is supplied with a vacuum relief valve **1** and an overpressure valve **2**.
Overpressure valve opening pressure of 0.7 bar.

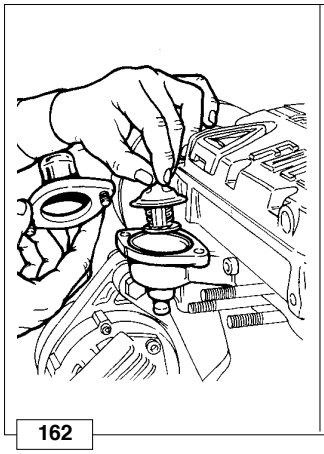


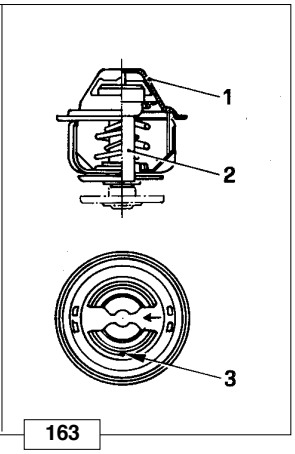
161

Coolant circulation pump, components

1 Rotor
2 Front seal gasket
3 Pump casing
4 Exhaust hole
5 Bearing
6 Pulley
7 Shaft

Note: The pump for LDW 1204-1204/T-1404 engines is different from the one of the other series (fig. 148) due to the presence of a ring between rotor **1** and gasket **2**.


162



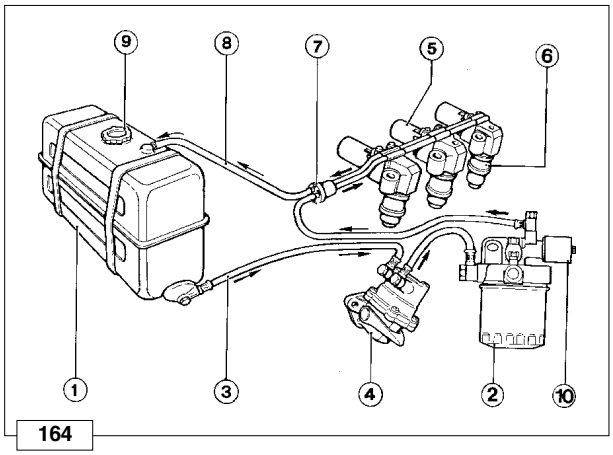
163

Thermostatic valve

1 - Stainless steel or brass casing
2 - Wax bulb
3 - Air relief hole

Characteristics:

Opening temperature: ..... 83°÷87°C
Max stroke at: ..... 94°C = 7 mm
Liquid recycling: ..... 30÷80 l/h.



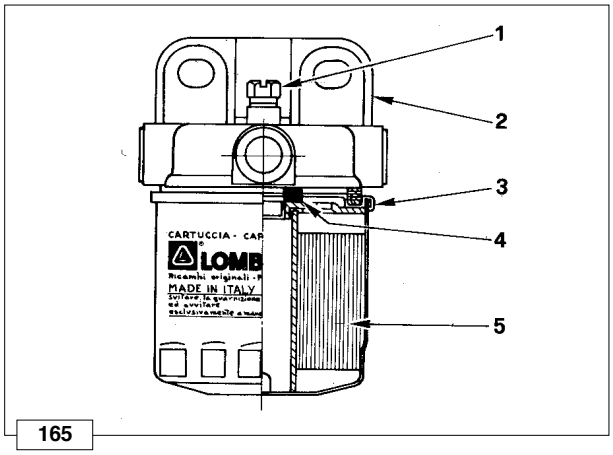
164

Fuel feeding / injection circuit

Components:

1 Fuel Tank
2 Fuel filter
3 Fuel feeding tube
4 Fuel lift pump
5 Injection pump
6 Injector
7 Fuel rail passage rubber joint
8 Injector exhaust pipe
9 Fuel tank cap
10 Solenoid valve

Note: The tank complete with filter is supplied on request.



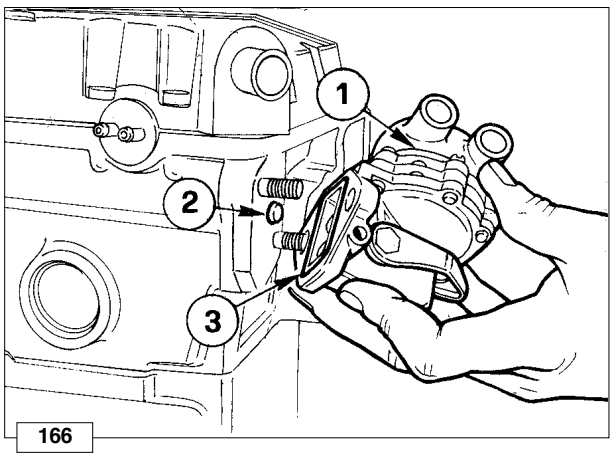
165

Fuel filter detached from the tank (on request)

1 Air relief valve
2 Bearing
3 Cartridge
4 Rubber element
5 Filtering element

Cartridge characteristics:
Filtering paper: ..... PF 905
Filtering surface: ..... 2400 cm^2
Degree of filtration: ..... 2÷3 µ
Maximum operating pressure: ..... 4 bar

➲ See page 24 for periodic maintenance details.



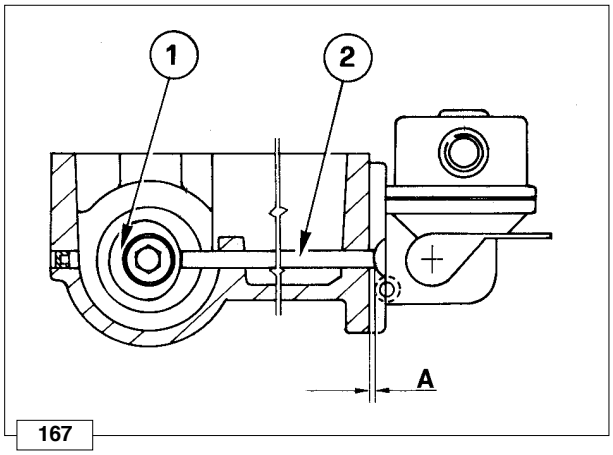
166

Fuel lift pump

Components:
1 Fuel lift pump
2 Push rod
3 Seal ring

The fuel pump is membrane type. It is driven by camshaft cam via a drive rod.
It is equipped with an external manual fuel lever.

Characteristics:
With the control cam at 1500 rpm the delivery rate is 75 l/hours and the self-adjusting pressure is at 0.55 to 0.65 bar.



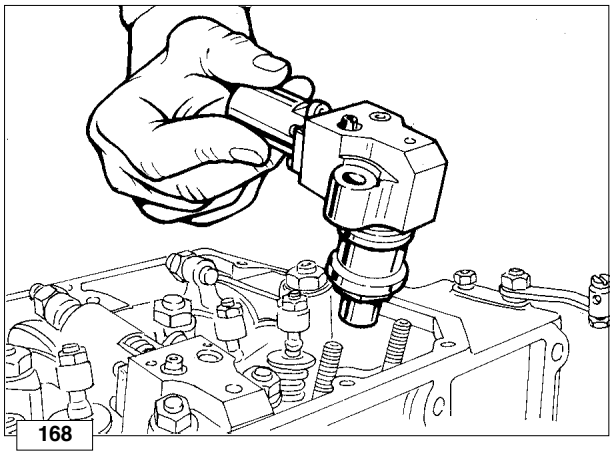
167

Fuel pump drive rod projection

The protrusion **A** of drive rod **2** from the cylinder head surface is 1.66÷2.18 mm.
The check must be carried out with cam **1** idle as in the figure.

❍ Block the two fuel pump fastening nuts simultaneously at 24 Nm.

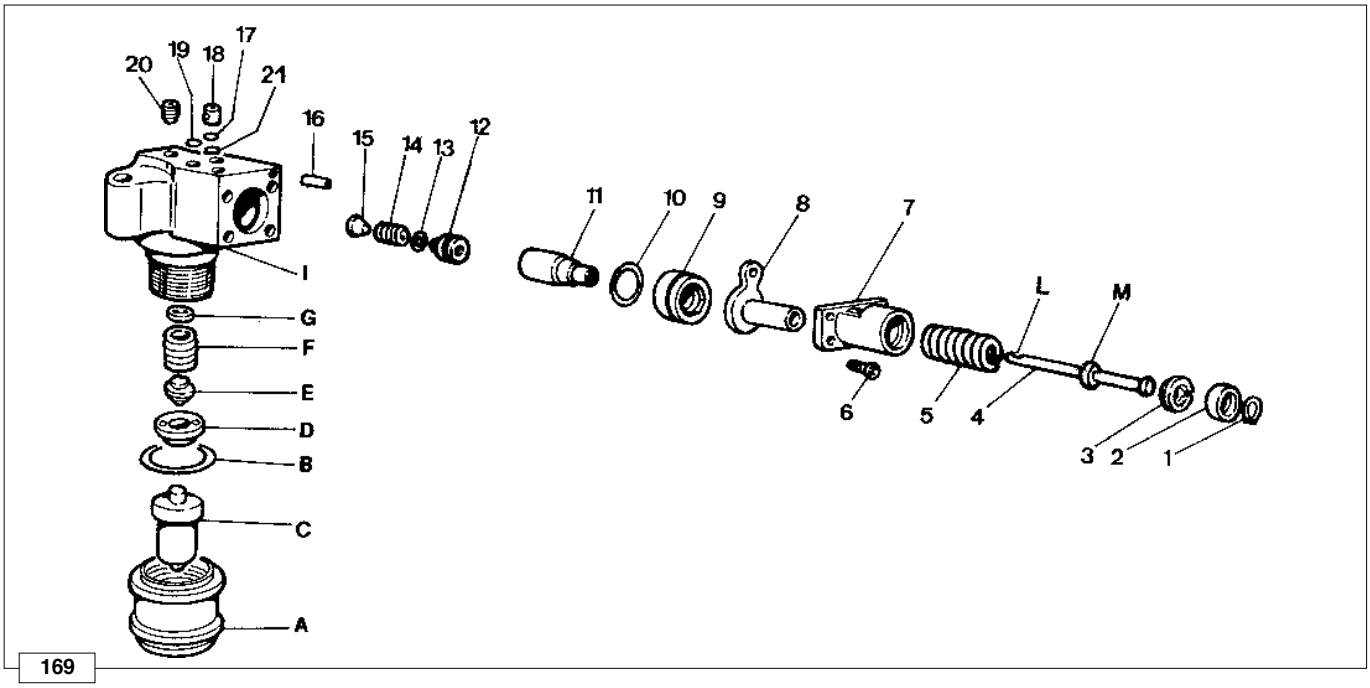
Check the length of the drive rod and if it is not the right size, replace it.
Drive rod length = 153.15÷153.35 mm.


168

Pump/injector unit

Designed by LOMBARDINI, the pump/injector is exclusive to FOCS series engines.
The injection system includes two, three, four identical pumps/injector units, each one of which feeds a cylinder.

Note: On pumps/injector units of recent construction (for serial numbers and references see the table on page 78) the pump has been modified (see fig. 174).
Following to this modification and others like the elimination of cap **20** of fig. 169 the method of checking the static injection advance has changed as well, fig. 187-188 as that of injector setting, fig. 178.



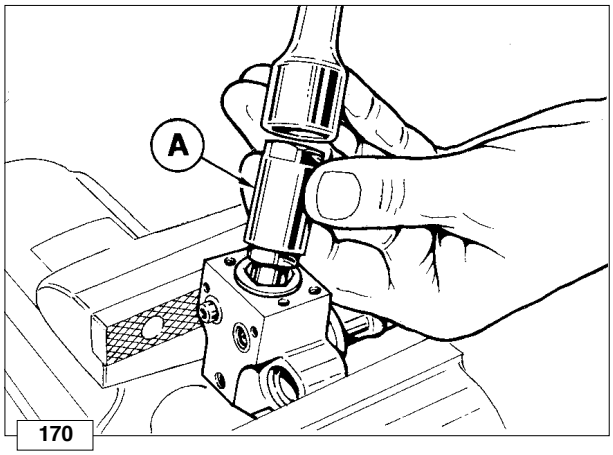
169

Pump/injector unit, components

1 Seeger ring
2 Tappet
3 Stop plate
4 Plunger
5 Spring
6 Screw
7 Bearing
8 Lever
9 Ring nut
10 Plunger guide O-ring
11 Cylinder
12 Delivery valve
13 Gasket
14 Spring
15 Filler
16 Pin
17 O-ring
18 Non-return valve
19 O-ring
20 Cap screw (old type)
21 Metal gasket (new type)

A Ring nut
B O-ring
C Nozzle
D Spacer
E Pressure rod
F Spring
G Spacer
I Casing
L Control spiral
M Plunger guide

❍ When remounting the injector tighten ring nut A at 70 Nm

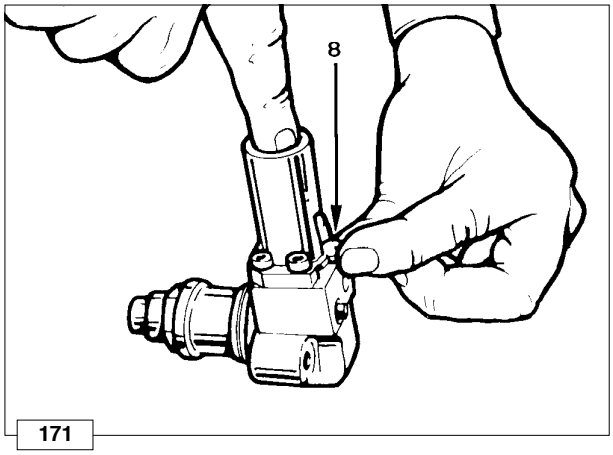


170

Plunger barrel ring nut assembly/disassembly

To disassemble ring nut **9** fig. 169, use the suitable wrench **A** se.no. 7107-1460-029

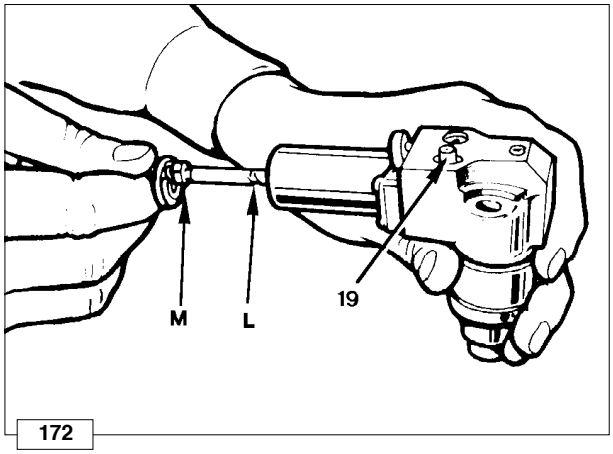
❍ When refitting tighten it a torque of 34 Nm.



171

Injection pump assembly/disassembly

Disassemble the unit following the progressive order of fig. 169.
Reassemble following the same steps in reverse order.
During reassembly, turn the plunger spiral **L** towards the non-return valve **19**, as follows.

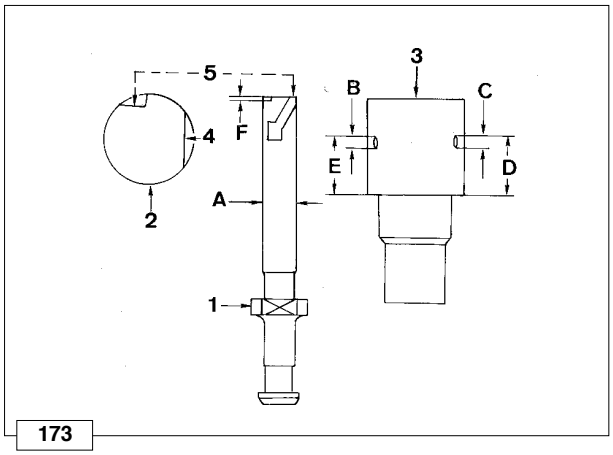


172

Plunger injection pump reassembly

To be able to insert the plunger in its barrel press with a finger and at the same time slowly rotate lever **8** fig. 171 until guide **M** of the plunger fig. 172 enters the lever seating.

Note: If by mistake the plunger is mounted with the spiral in the wrong direction the pump won't function (there is no danger that the engine runs away).



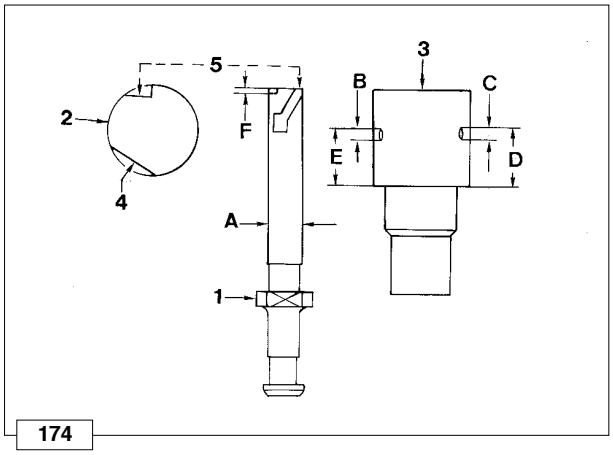
173

Pumping element (old-type injection pump)

1 Plunger
2 Upper plunger section
3 Plunger barrel
4 Delay notch
5 Control slot

Dimensions (mm):

A	5,5	nominal value
B	2,00 ÷ 2,03	inlet hole diameter
C	1,50 ÷ 1,53	outlet hole diameter
D	10,00	
E	9,6	
F	0,7	

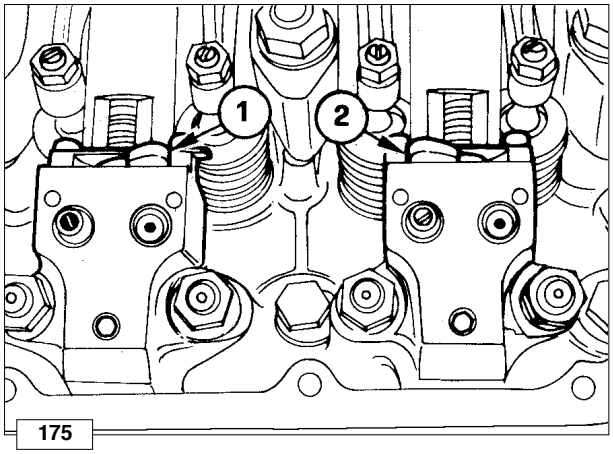


174

Pumping element

1 Plunger
2 Upper plunger section
3 Plunger barrel
4 Delay notch
5 Control slot

	INJECTION PUMP	Dimensions					
		A	B	C	D	E	F
~~502 Aluminium crankcase~~	6~~590.307~~	~~5.~~5	1.50 ÷ 1.55	1.50 ÷ 1.53	9.965 ÷ 10.035	9.565 ÷ 9.635	0.9
~~502 602 903 1204~~	6~~590.285~~	~~6.~~0					
~~1204/~~T ~~702 100~~3-1404	6590.290	6.5					



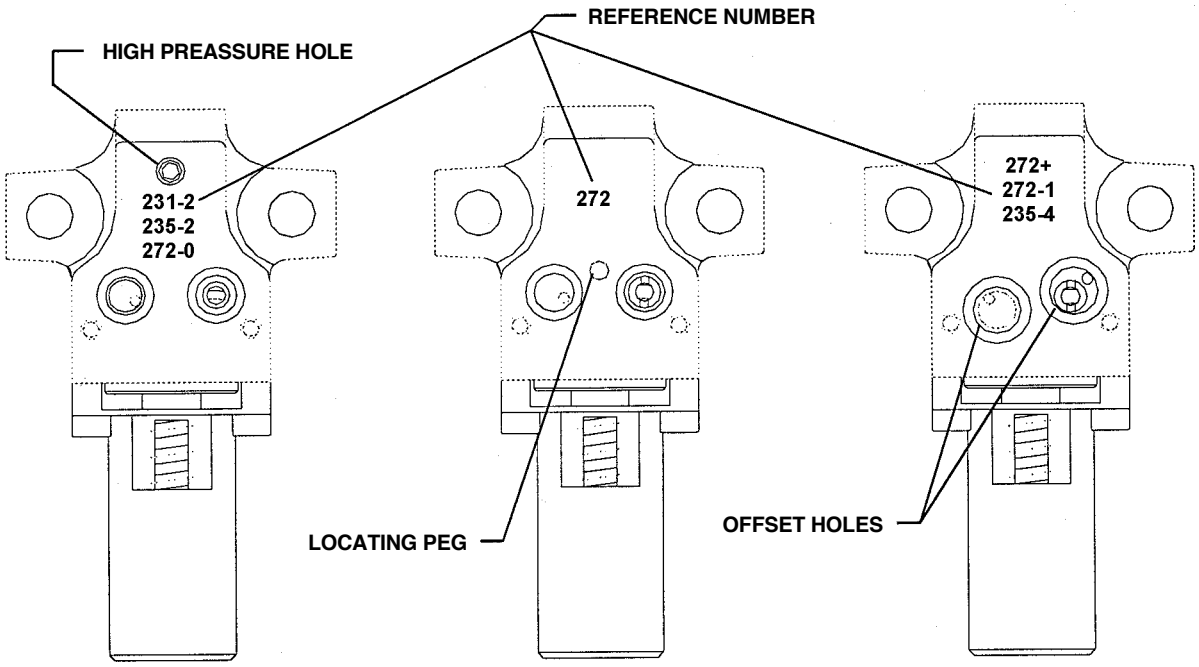
175

Pump/injector unit se.no. 6590.285 control data.

1 Delivery control lever on stop position.
2 Delivery control lever on maximum delivery position.

Rod stroke form max delivery position (mm)	Rpm (*)	mm³/stroke
9,5	3600	19÷23
9,5	1200	15÷24
start position	300	35÷38

Injector setting pressure: 140÷155 bar
* Rpm rating is that of the crankshaft.

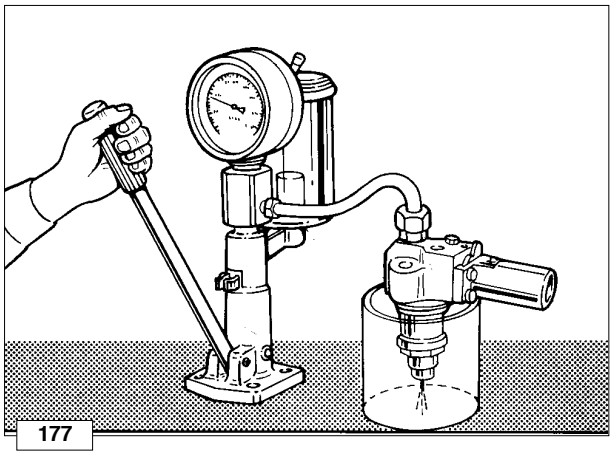


176

Lombardini injection system is being steadily implemented, seeking the best performance of its engines.
For this reason the pump injector body has been modified three times in the course of its evolution.
Three different pump injectors are shown in the top figure.

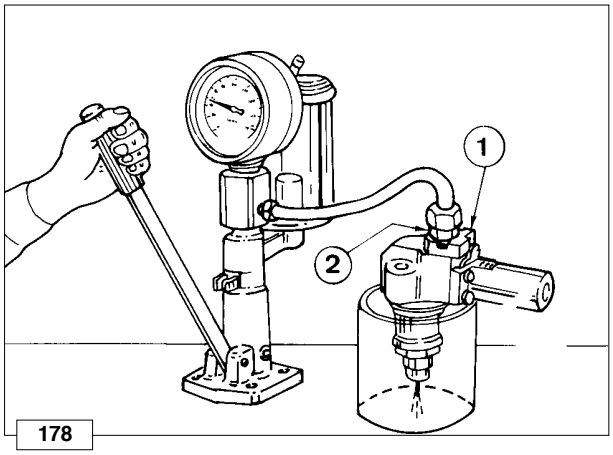
Old type injector pump: it is characterised by its high pressure hole
Intermediate injector pump: is characterised by not having the high pressure hole (the hole can be there but it is only used to control the injector and injection advance) and by the locating peg between inlet and outlet holes.
Current pump injector: it is characterised by its offset inlet and outlet holes. These are also oversized, due to the absence of the high pressure hole.

REFERENCE N°	CODE N°	ENGINE TYPE	INJECTION ADVANCE VALUE	SPECIAL TOOLS
~~231-2~~	~~6590.262~~	~~502 - 602 - 903 - 1204~~	~~11° - 13°~~	~~ADVANCE ..... 1460.028 + 1460.024~~ ~~INJECTOR SETTING ..... 1460.028~~ ~~T.D.C. ..... 1460.048~~
~~272-0~~	~~6590.283~~	~~502 MINI CAR~~	~~11° - 13°~~	~~ADVANCE ..... 1460.028 + 1460.024~~ ~~INJECTOR SETTING ..... 1460.028~~ ~~T.D.C. ..... 1460.048~~
~~235-2~~	~~6590.235~~	~~1204/T~~	~~4° - 6°~~	~~ADVANCE ..... 1460.028 + 1460.024~~ ~~INJECTOR SETTING ..... 1460.028~~ ~~T.D.C. ..... 1460.048~~
~~272~~	~~6590.272~~	~~502 - 602 - 903 - 1204~~	~~8° - 10°~~	~~ADVANCE ..... 1460.056~~ ~~INJECTOR SETTING ..... 1460.028~~ ~~T.D.C. ..... 1460.048~~
~~272-1~~	~~6590.285~~	~~502 - 602 - 903 - 1204~~	~~8° - 10° < 2999 g/min~~ ~~12° - 14° > 3000 g/min~~	~~ADVANCE / INJECTOR SETTING ..... 1460.074~~ ~~T.D.C. ..... 1460.048~~
~~272-~~ ~~272+~~	~~6590.286~~ ~~6590.307~~	~~502 MINI CAR~~	~~11° - 13°~~	~~ADVANCE / INJECTOR SETTING ..... 1460.074~~ ~~T.D.C. ..... 1460.048~~
~~235-4~~ ~~235-4~~	~~6590.290~~ ~~6590.287~~	~~1204/T~~	~~6° - 8°~~	~~ADVANCE / INJECTOR SETTING ..... 1460.074~~ ~~T.D.C. ..... 1460.048~~
235-3 235-4	6590.290	702 - 1003 - 1404	8° ÷ 10° < 2999 g/min 12° ÷ 14° 3000÷3600 g/min 13° ÷ 14° > 3600 g/min	ADVANCE / INJECTOR SETTING ..... 1460.074 T.D.C. 1460.048


177

Injector, setting (old type)

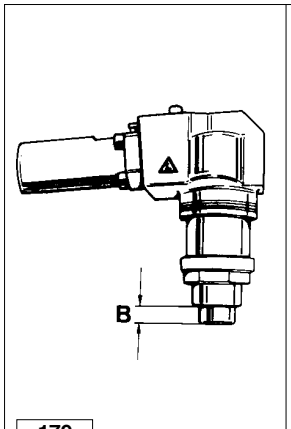
Connect the injector to a hand pump after removing cap screw **20** fig. 169.
By means of the tool - se.no. 7107-1460-028 - check that the setting pressure is 130÷145 bar.
Adjust, if necessary, by changing the spacer located under the spring.
There are eleven different spare part spacers from 1 to 2 mm.
When you replace the spring, the setting should be made at a pressure higher than 10 bar to compensate for adjustments in operation.
Check the needle seal by slowly actuating the hand pump for 10 seconds, until you reach abt. 130 bar.
If the nozzle drips, replace it.



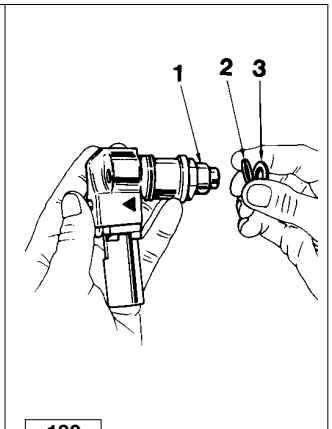
178

Setting of injector according to current pump/injector unit

Remove the non-return valve leaving its metal gasket and fit a cap screw in its place, that is part of tooling 7107-1460-074.
Mount then head **1** and coupling **2**.
Then connect a hand pump as shown in the picture.
The pressure setting must be 140÷155 mm bar.



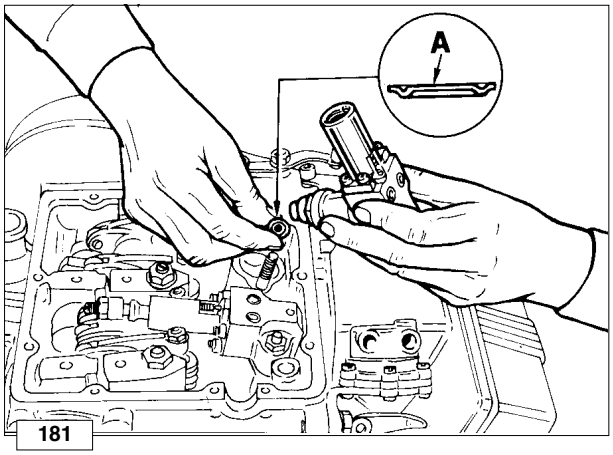
179



180

Injector, nozzle projection

To avoid excessive compression of the spark arrester **A**, fig. 181, check projection **B** of the nozzle fig. 179.
B = 6.80÷7.05 mm.
If this measure is larger put spacer **2** between ring nut **1** and copper gasket **3**.
0.25 mm thick spacers are available.



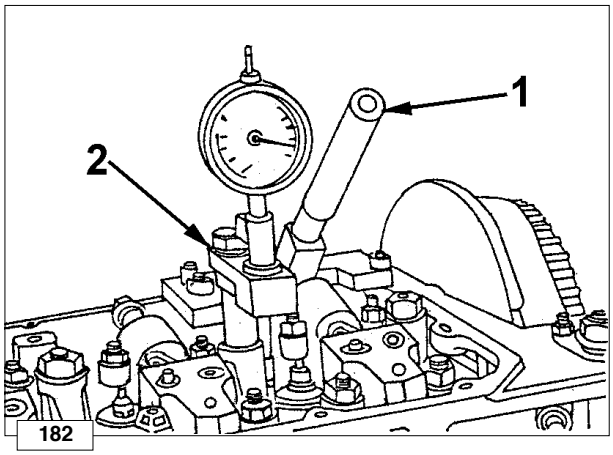
181

Injector, spark arrester

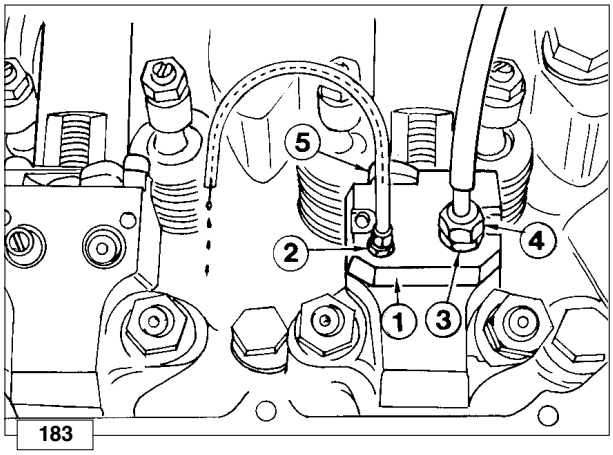
Every time you remove the pump/injector you must replace the spark arrester, the copper gasket, the oil O-ring, as well as the 2 fuel O-rings.
Insert the spark arrester in the injector housing with surface **A** pointing upwards.

❍ Tighten simultaneously both nuts that fasten it to the head at 20 Nm.
For engines with the injectors fixed with self-locking nuts, tighten the nuts at 23 Nm.

➲ See page 24 for periodic maintenance details.



182



183

Injection advance control and regulation

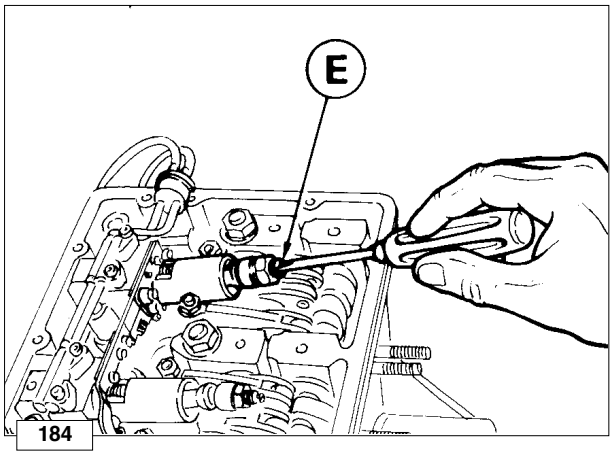
- Dismount the rocker arm cover, see page 40.
- Position the device on the head, in contact with cylinder no. 1.
- Mount the dial gauge on the valve controlled by tool ref. 1460.048.
- Via lever **1** of the tool, open the valve until it comes into contact with the piston.
- Then rotate the crankshaft until the TDC is read in the dial gauge. Then reset the hundredths.
- Remove the fuel pipes.
- Remove the O-ring in contact with the non-return valve and replace it with the appropriate gasket - equipment component part ref. 1460.074. Once the check has been completed, remove the gasket and refit the O-ring.
  Connect tool 1460.074 on pump n° 1. This will automatically position the control lever to the maximum delivery. The tool is provided with 3÷4 couplings for connection to a tank that must be not lower than 30 cm from the pumps level. Coupling 2 is equipped with a plastic pipe with internal drip collecting wire.
- Put cylinder 1 under compression and open the tank tap. Fuel diesel will start to flow out from coupling 2.
- Slowly rotate the engine towards TDC 1 until the diesel fuel stops leaking out.
- At this point with lever **1** (of fig. 182) move again the valve until it touches the piston and read on the dial gauge how many hundredths are missing from the previously reset value (TDC).
- To convert hundredths into degrees, consult the table below.
- Repeat the operation on the other cylinders.

α	~~LDW 502 (mm)~~	~~LDW 602 903 1204 1204/T (mm)~~	LDW ~~702 100~~3-1404 (mm)
18°	1.947	2.367	2.468
17°	1.739	2.115	2.205
16°	1.543	1.876	1.956
15°	1.358	1.651	1.721
14°	1.184	1.440	1.501
13°	1.022	1.242	1.296
12°	0.871	1.059	1.105
11°	0.733	0.891	0.930
10°	0.606	0.737	0.769
9°	0.491	0.597	0.623
8°	0.388	0.472	0.493
7°	0.297	0.362	0.378
6°	0.218	0.266	0.277

Injection advance for currently used pump/injector unit

Engine	Code	Reference n°	Rpm	α
~~502 602 903 1204~~	~~6590 285~~	~~272 1~~	~~1500 : 2999~~	~~8° : 10°~~
~~502 602 903 1204~~	~~6590 285~~	~~272 1~~	~~> 3000~~	~~12° : 14°~~
~~502*~~	~~6590 307~~	~~272+~~	~~3000 : 3600~~	~~10° : 12°~~
~~702 1003~~ 1404	6590-290	235-4	1500÷2999	8°÷10°
~~702 1003~~ 1404	6590-290	235-4	3000÷3600	12°÷14°
~~702 100~~3 1404	6590-290	235-4	> ÷3600	13°÷15°
~~1204/T~~	~~6590 290~~	~~235 4~~	~~1500 : 3600~~	~~6° : 8°~~

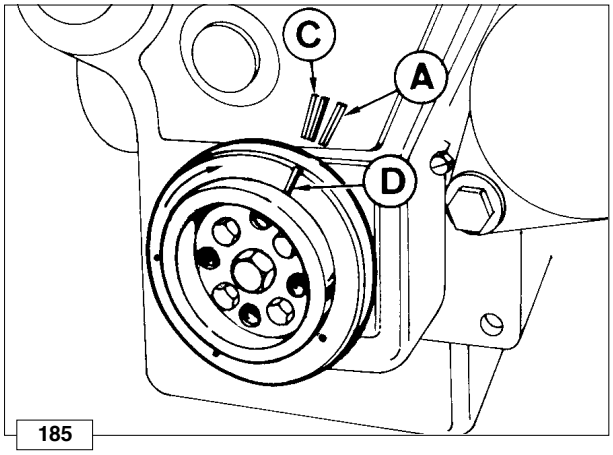
~~* With aluminuim crankcase~~



184

Static injection advance tuning

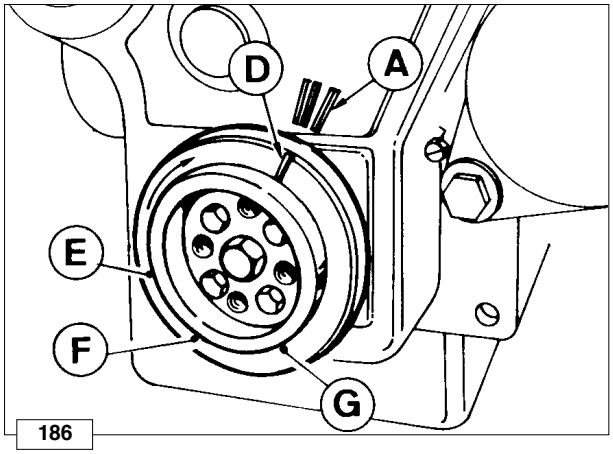
If the injection advance value found does not correspond to the previously described value, adjust the screw **E** and repeat the test.
Rotating screw **E** by ½ turn will change the injection advance by 5°.
If turned clockwise, injection is advanced.
In the opposite direction, injection is delayed.



185

Injection advance references on timing belt protector

The method of checking injection advance is essentially the same as that described in fig. 182 with one difference: instead of using the device se.no. 7107-1460-048 with which you measure piston lowering with respect to the Top Dead Centre, you use references **A** and **C** on the timing belt protector and reference **D** located on engine pulley.
When **D** coincides with **A** the piston has reached its TDC.
When **D** coincides with **C** the piston is in injection advance position.

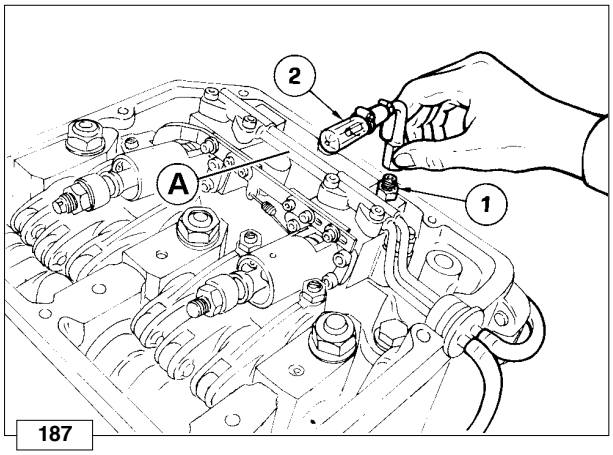


186

TDC (Top Dead Center) references

D coincides with **A** = TDC of 1st cylinder of all series engines, of 4th cylinder LDW ~~1204-1204/~~T-1404, ~~and of 2nd cylinder LDW 502~~.
~~**E** coincides with **A** = TDC of the 2nd cylinder LDW 903-1003.~~
F coincides with **A** = TDC ~~of 2nd cylinder LDW 602-702.~~, of 3rd and 2nd cylinder LDW ~~1204-1204/T-~~1404.
~~**G** coincides with **A** = TDC of 3rd cylinder LDW 903-1003.~~

Note: Following the arrow's rotation direction, ~~the combustion order for LDW 903-1003 is **D**, **G**, **E** (1st – 3rd – 2nd cylinder respectively~~. As to LDW ~~1204-1204/T-~~1404 the sequence is **D**, **F**, **D**, **F** (1st– 3rd– 4th and 2nd cylinder).



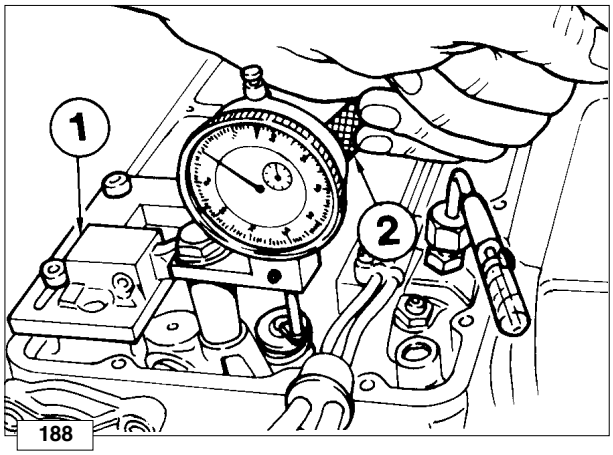
187

Tester and special coupling for injection advance control (Old-type injection pump)

1 Special coupling. Serial number: 7107-1460-028
2 Injection advance tester. Serial number: 7271-1460-024.

Remove the cap on the pump/injector casing and in its place screw on coupling **1**.
On this coupling tighten the tester **2**.

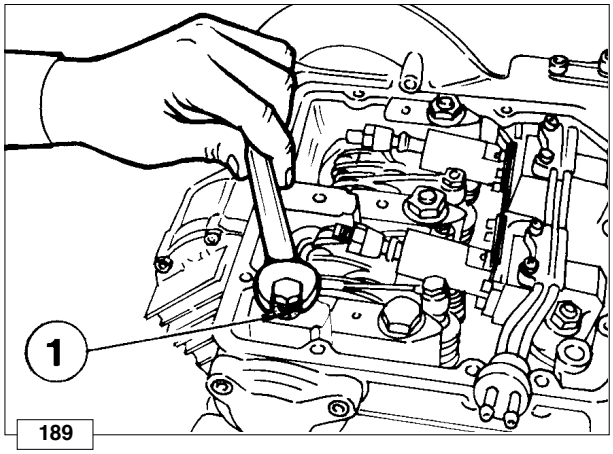
Note: When reassembling the cap on the pump/injector unit, check its seal.



188

Static injection advance regulation

Fill the tank and operate the fuel pump.
Set the pump/injector delivery control rod (ref. **A** fig. 187) at half-stroke.
Bring the piston to the top dead centre of compression. Fit a 13 mm hexagon wrench on the injection advance adjusting screw lock nut. By turning the wrench forth and back you prime the injection pump, thus enabling the tester to be drained.
With the piston at its TDC, operate lever **2** fig. 188 and bring the drain valve into contact with the piston. Then reset dial gauge.
Go back ¼ of a turn moving the crankshaft anticlockwise. Then turn forward again very slowly
observing the fuel level inside the tester. As soon as the level changes, then stop. You reached the static injection advance.
~~By actuating lever **2** check piston lowering with respect to the TDC that shall be between 0.89 and 1.24 mm for LDW 602-903-1204, and between 0.73 and 1.02 for LDW 502 engine model.~~
The table on page 80 shows both piston lowering expressed in mm, with respect to the TDC, and the corresponding rotation of the crankshaft, expressed in degrees.
The static injection advance in degrees α = 11° to 13° refers to all engines for adjustments from 1500 / 3600 rpm.



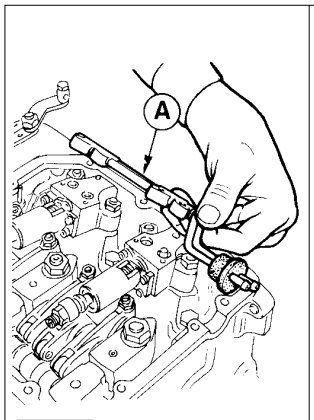
189

Preliminary steps to pump/injector unit delivery balancing test

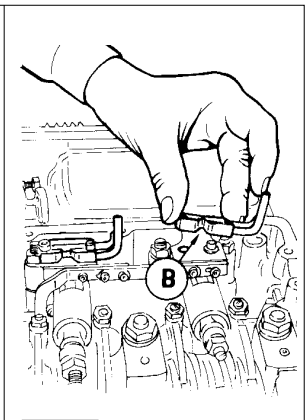
Closing the oilhole

To perform this test you must remove the rocker arms cover and close hole **1** with an M 8x1.25 or M 10x1.5 screw (on latest model engines) not longer than 8 mm. Also remove the copper gasket.
If the camshaft and rocker arms are dry, lubricate them with engine oil.

Note: If you only want to check the nozzle it is not necessary to balance the deliveries; provided that when you dismount the rod you do not loosen adjusting screws **1** and **2** (fig. 193).



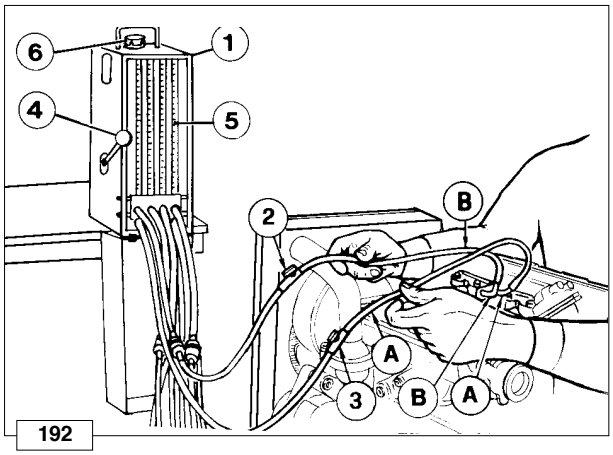
190



191

Test head B assembly

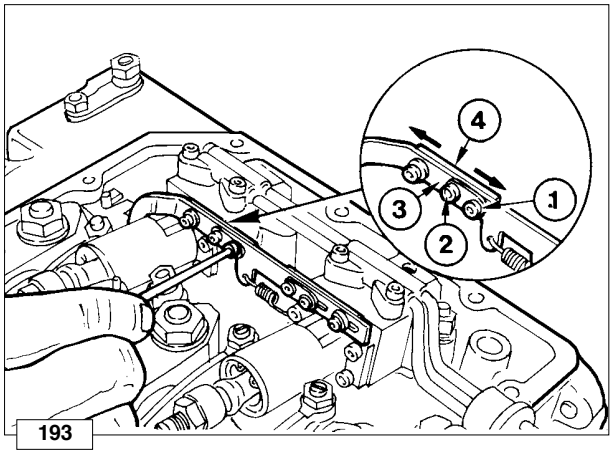
Remove fuel pipe **A** and mount one test head **B** in its place per pump/injector.
The test heads complete with pipes are supplied together with instrument ref. 7104-1460-069.



192

Instrument connection

Place the instrument **1**, se.no. 7104-1460-127 at least 20 cm above the pump/injector level.
Connect pipe **A** (outlet from every instrument test piece) with pipe **A** (inlet of every pump/injector) and pipe **B** (return to the instrument) with pipe **B** (outlet from the pump/injector).
Open tap **2** and **3** of each pipe and fill the instrument with diesel.
Start the engine and bring it to 1500 rpm idle running.
Close the fuel supply to the engine from the instrument's tank using lever **4** and after 1 minute observe the levels in the test piece.
If a level goes down more than the others it is necessary to decrease the delivery of the corresponding pump (see below) and vice versa to increase the delivery if the level increases.



193

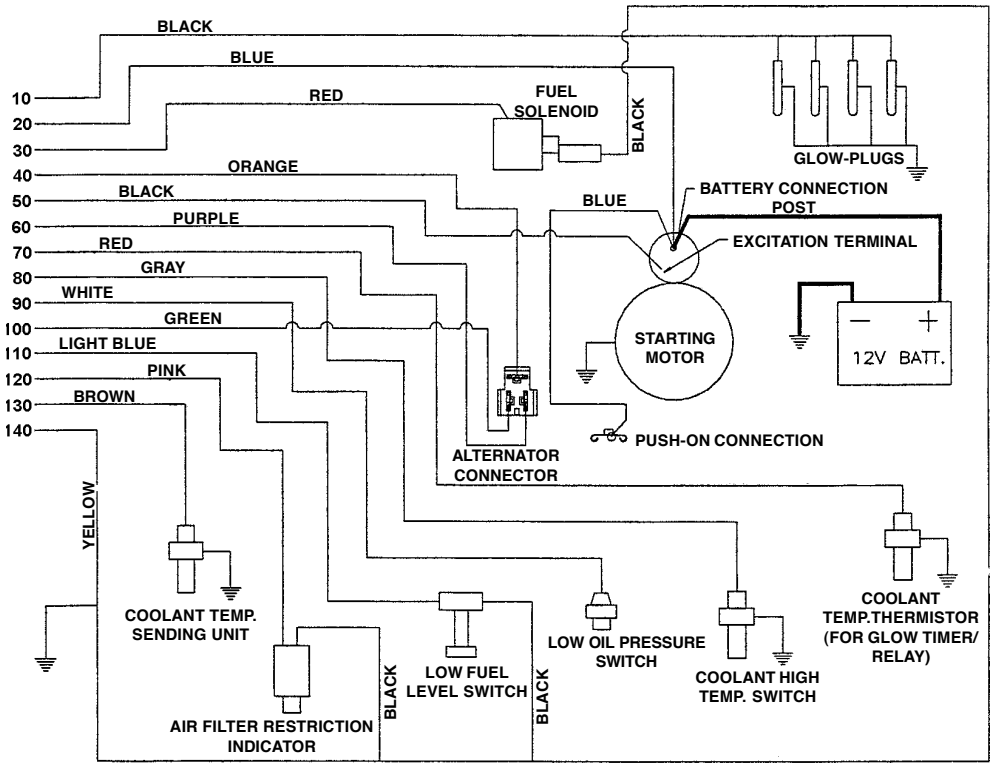
Injection pumps delivery balancing

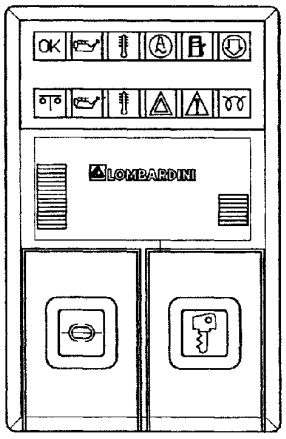
In case the balancing error read on the test pieces is greater than 2 cm^3/min, then injection pumps deliveries should be adjusted.
Plate **4** and rod **3** are blocked by screws **1** and **2**. Loosen them.
Move plate **4** rightwards with respect to rod **3** if you want to increase delivery.
If moved leftwards delivery decreases. Make very small movements with the plate.

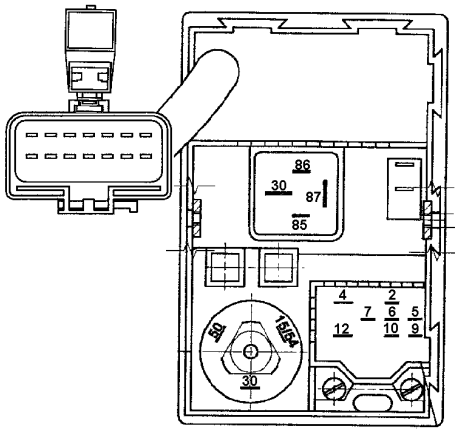
❍ Tighten screws **1** and **2** at a torque of 1,1 Nm.

Note: Each time a pump/injector is replaced it is necessary to balance the deliveries.

ELECTRIC CONTROL PANEL WITH AUTOMATIC ENGINE STOP (UPON REQUEST)

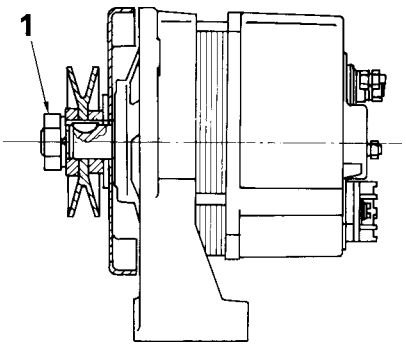






AUXILIARY TERMINALS	
4	(+) Positive pole under key (6.3)
12	(-) Negative pole - Earth (6.3)
2	Signal for temp. water instrument (4.75)
10	Signal for electric rev. counter (4.75)
7	Oil pressure signal (4.75)
6	Protected socket available (4.75)
5	Protected socket available (4.75)
9	Rear connection – Jumper with 6 for alternator protection

Control panel auxiliary terminals **2**, **4**, **5**, **6**, **7**, **10** and **12** are also accessible from the front, under the fuse access door.

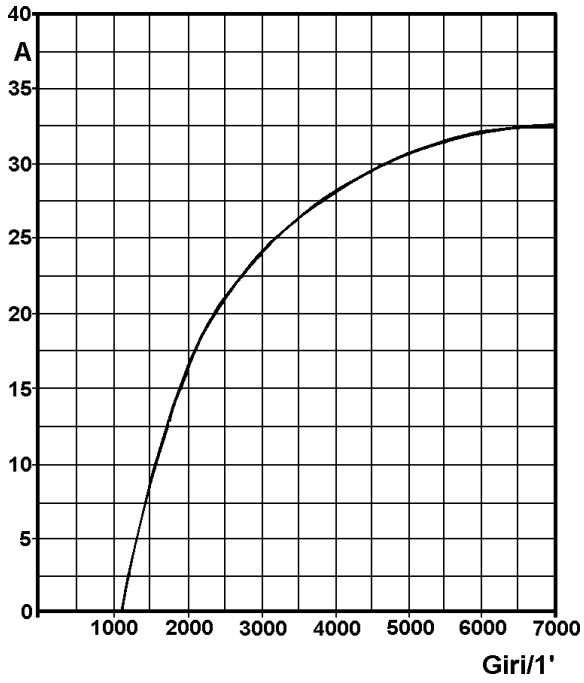


194

Alternator, Iskra 14V 33A

Nominal voltage 14V
Nominal current output 33A
Maximum Rpm ..... 12.000 giri/1'
Maximum peak Rpm ..... 13.000 giri/1'
Voltage regulator AER 1503
Rotation (viewed at puley end): Clockwise

❍ Tighten nut **1** at a torque of 35÷45 Nm.

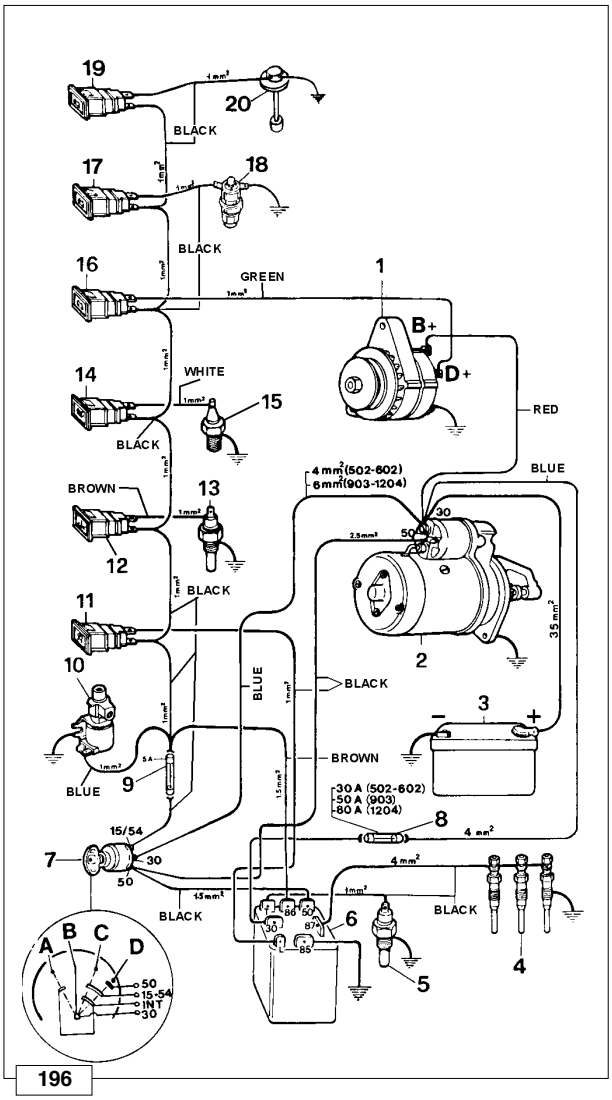


195

Alternator, Iskra 14V 33A - Performance Curve

The curve was obtained at room temperature of +25°C with 13 V battery voltage.

Note: The rpm shown on the table are referred to the alternator. Engine rpm/alternator rpm ratio, with driving pulley diameter 88 mm = 1:1.23



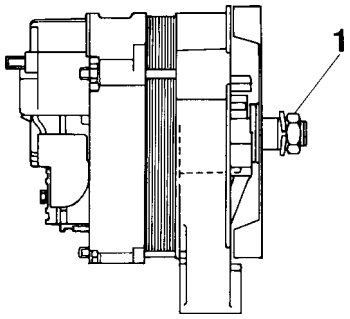
Electric starting layout (12V) with Iskra alternator 14V 33A

1 Alternator
2 Starter Motor
3 Battery
4 Glow Plugs
5 Coolant temperature thermistor
6 Glow Plug Controller / Timer
7 Key Switch
8 System Fuse, ~~30A for LDW 502-602-702; 50 A for LDW 903-1003;~~ 80 A for LDW ~~1204-1204/T-~~1404.
9 Fuse (Accessory)- 5A
10 Fuel Solenoid Valve
11 Glow Plug Indicator Lamp
12 Coolant High Temperature Lamp
13 Coolant High Temperature Switch
14 Oil Pressure (Low) Lamp
15 Oil Pressure Switch
16 Alternator Charging Lamp
17 Air Filter High Restriction Indicator Lamp
18 Air Filter Restriction Switch
19 Low Fuel Level Lamp
20 Low Fuel Level Switch

A Accessory Position
B Off Position
C On Position
D Starting Position

Note: Battery **3** not supplied by LOMBARDINI.
For assembly we recommend a battery with the following characteristics, see table below.

Engine type	Starter motor class (epicyclic type) Kw	Normal starting conditions		Heavy-duty starting conditions (max allowed)	
		Capacity K20 - Ah	Rapid discharge intensity (DIN Standards at -18° C) A	Capacity K20 - Ah	Rapid discharge intensity (DIN Standards at -18° C) A
~~502~~	~~1,2~~	~~44~~	~~210~~	~~66~~	~~300~~
	~~1,1~~	~~44~~	~~210~~	~~66~~	~~300~~
~~602-702~~	~~1,1~~	~~44~~	~~210~~	~~66~~	~~300~~
	~~1,6~~	~~66~~	~~300~~	~~88~~	~~330~~
~~903-1003~~	~~1,1~~	~~44~~	~~210~~	~~66~~	~~300~~
	~~1,6~~	~~66~~	~~310~~	~~88~~	~~330~~
~~1204~~-1404	1,1	44	210	66	300
	1,6	66	300	88	330
~~1204/T~~	~~1,1~~	~~55~~	~~255~~	~~66~~	~~300~~
	~~1,6~~	~~66~~	~~300~~	~~88~~	~~330~~



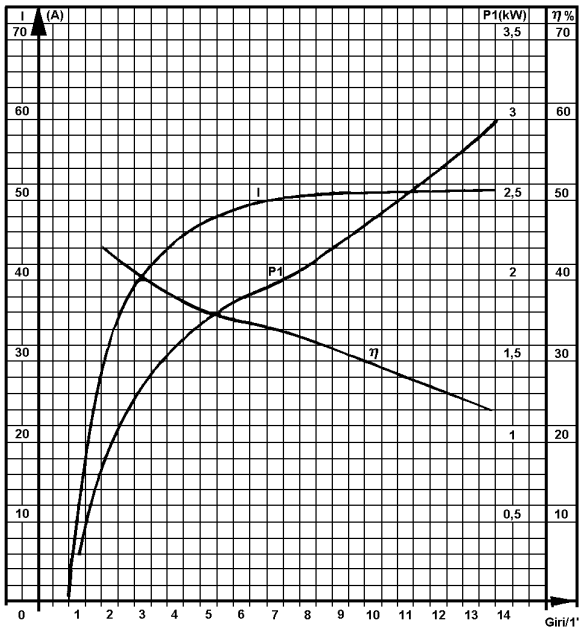
197

Alternator, Marelli type AA 125 R 14V 45A

Characteristics:
Nominal voltage ..... = 14V
Nominal current output ..... = 45A
Maximum Rpm ..... = 14000 giri/1'
Maximum peak Rpm (for 15') ..... = 15000 giri/1'
Bearing, Pulley End ..... = 6203-2Z
Bearing, Voltage Regulator End ..... = 6201-2Z/C3
Voltage regulator ..... = RTT 119 A
Rotation (viewed at puley end): Clockwise

Note: Use only high temperature grease when servicing bearings

❍ Tighten nut **1** at a torque of 60 Nm.



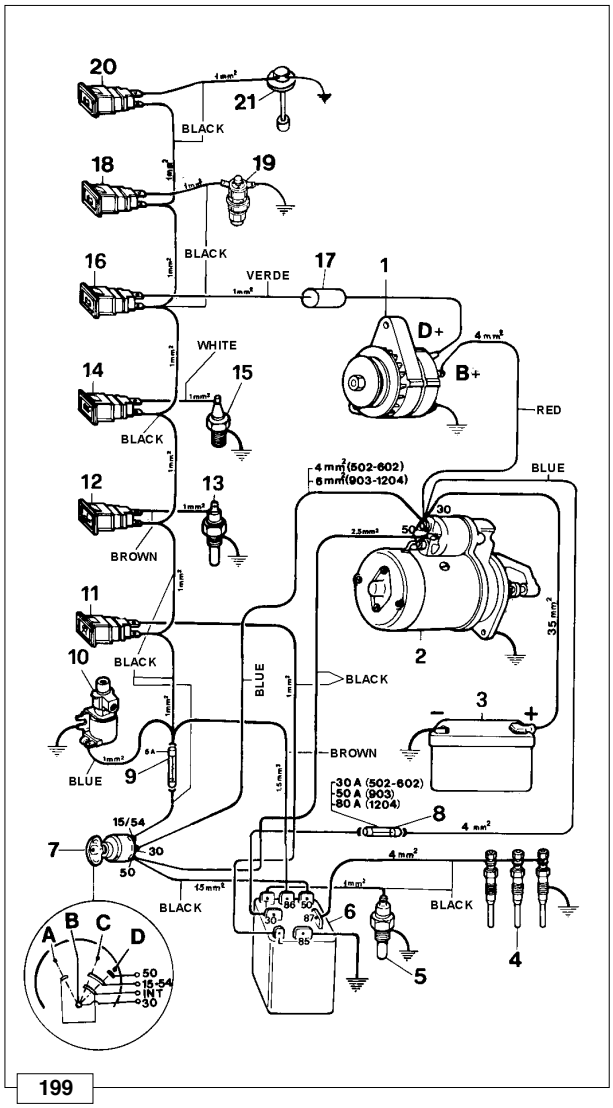
198

Alternator, Marelli type AA 125 R 14V 45A - Performance Curve

The curve was obtained at room temperature of +25°C with a costant 13 V battery voltage.

P1 = Power Output (KW)
I = Current Output (Amps)
η = Efficiency

Note: The RPM shown is that of the alternator. The value of the rpm axis must be multiplied by 1000.
Alternator speed is a function of engine speed and the crankshaft pulley diameter. If the engine pulley is 88 mm, then the alternator speed ration is 1.3:1. If the engine pulley is 108 mm, then the alternator speed ratio is 1.6 : 1.



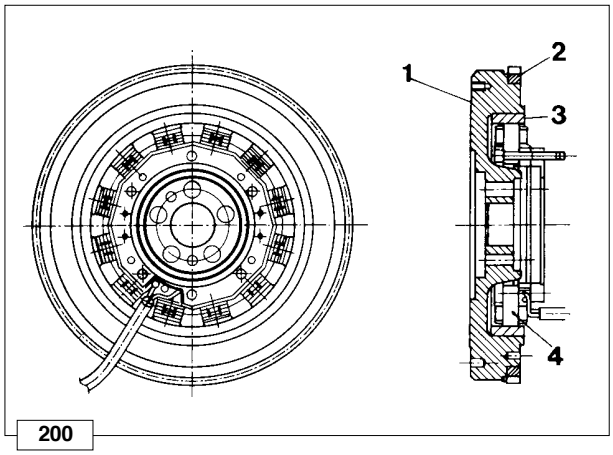
199

Electric starting layout (12V) with Marelli type AA 125 R 14V 45A alternator

1 Alternator
2 Starter Motor
3 Battery
4 Glow Plugs
5 Coolant temperature thermistor
6 Glow Plug Controller / Timer
7 Key Switch
8 System Fuse, ~~30A for LDW 502-602-702; 50 A for LDW 903-1003~~; 80 A for LDW ~~1204-1204/T-~~1404.
9 Fuse (Accessory)- 5A
10 Fuel Solenoid Valve
11 Glow Plug Indicator Lamp
12 Coolant High Temperature Lamp
14 Oil Pressure (Low) Lamp
15 Oil Pressure Switch
16 Alternator Charging Lamp
17 Diode
18 Air Filter Restriction Switch
19 Air Filter Restriction Switch
20 Low Fuel Level Lamp
21 Low Fuel Level Switch

A Accessory Position
B Off Position
C On Position
D Starting Position

Note: Battery **3** not supplied by LOMBARDINI, for battery characteristics see page 89.

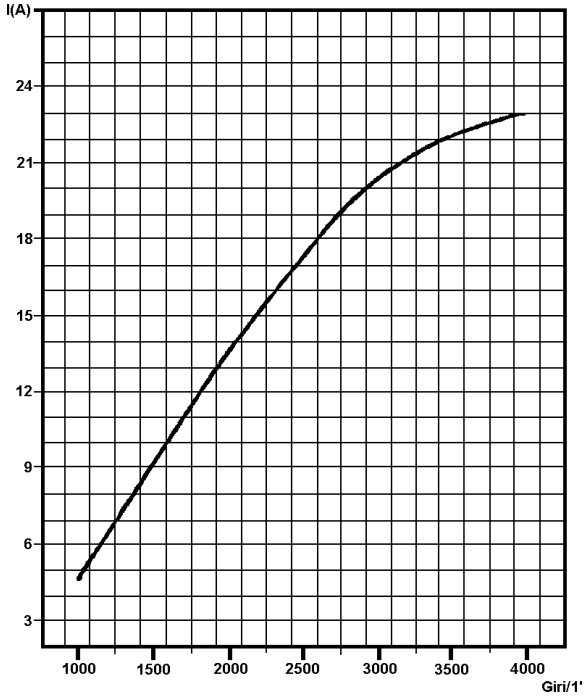


200

~~Flywheel Alternator~~

~~**12V 20A** with three cables at output~~
~~**12V 30A** with two cables at output~~

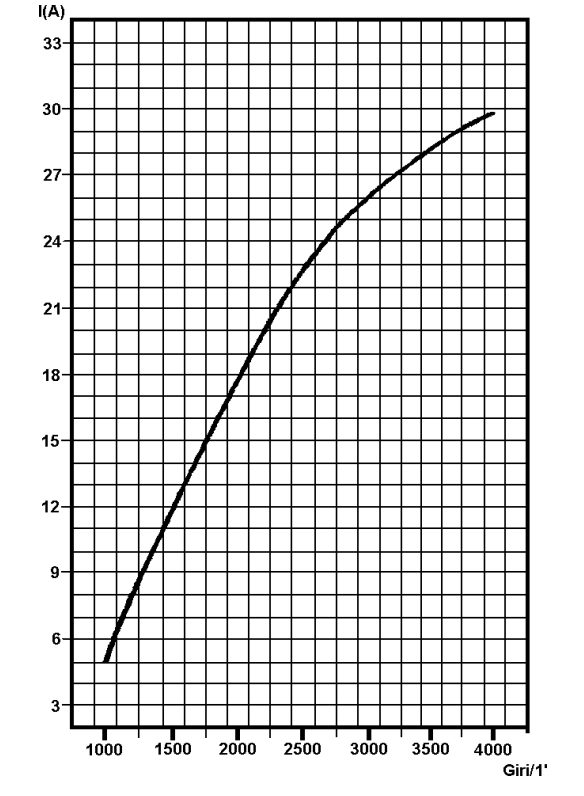
~~**1** Flywheel~~
~~**2** Ring gear~~
~~**3** Magnet ring (Rotor)~~
~~**4** Stator~~



201

Alternator battery charger curve 12V 20A
(three cables at output)

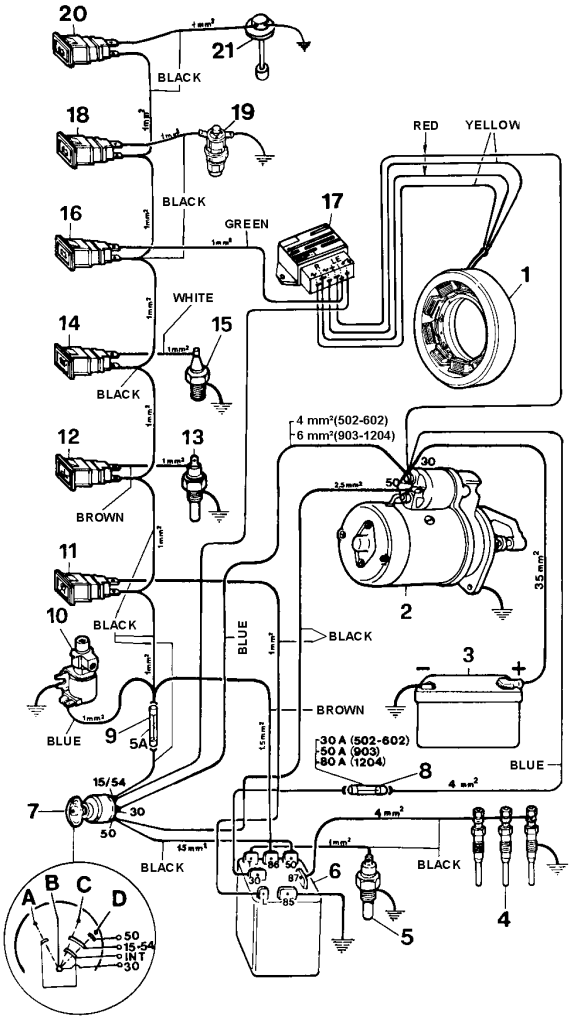
This curve is obtained at 20°C.
The statistical charging output of the flywheel alternator is +10% to -5% of the values shown.



202

Alternator battery charger curve 12V 30A
(two cables at output)

This curve is obtained at 20°C.
The statistical charging output of the flywheel alternator is +10% to -5% of the values shown.



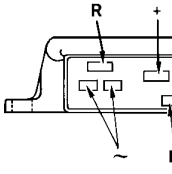
203

~~Electric starting layout (12V) with flywheel alternator~~

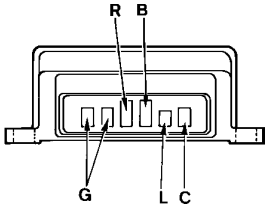
- ~~**1** Alternator~~
- ~~**2** Starter Motor~~
- ~~**3** Battery~~
- ~~**4** Glow Plugs~~
- ~~**5** Coolant temperature thermistor~~
- ~~**6** Glow Plug Controller / Timer~~
- ~~**7** Key Switch~~
- ~~**8** System Fuse, 40A~~
- ~~**9** Fuse (Accessory) 5A~~
- ~~**10** Fuel Solenoid Valve~~
- ~~**11** Glow Plug Indicator Lamp~~
- ~~**12** Coolant High Temperature Lamp~~
- ~~**13** Coolant High Temperature Switch~~
- ~~**14** Oil Pressure (Low) Lamp~~
- ~~**15** Oil Pressure Switch~~
- ~~**16** Alternator Charging Lamp~~
- ~~**17** Voltage regulator~~
- ~~**18** Air Filter High Restriction Indicator Lamp~~
- ~~**19** Air Filter Restriction Switch~~
- ~~**20** Low Fuel Level Lamp~~
- ~~**21** Low Fuel Level Switch~~

- ~~**A** Accessory Position~~
- ~~**B** Off Position~~
- ~~**C** On Position~~
- ~~**D** Starting Position~~

~~***Note:*** Battery **3** not supplied by LOMBARDINI.~~



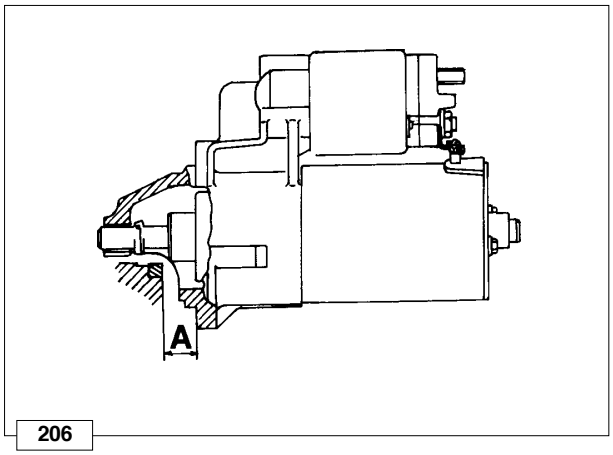
204



205

Voltage regulator connections

AETSA SAPRISA NICSA	Cable colour	DUCATI	*Conncetion dimensions*	
			Width	***Thickness***
~	Yellow	G	6,35	0,8
R	Red	R	9,50	1,2
+	Red	B	9,50	1,2
LE	Green	L	4,75	0,5
⊸	Brown	C	6,25	0,8



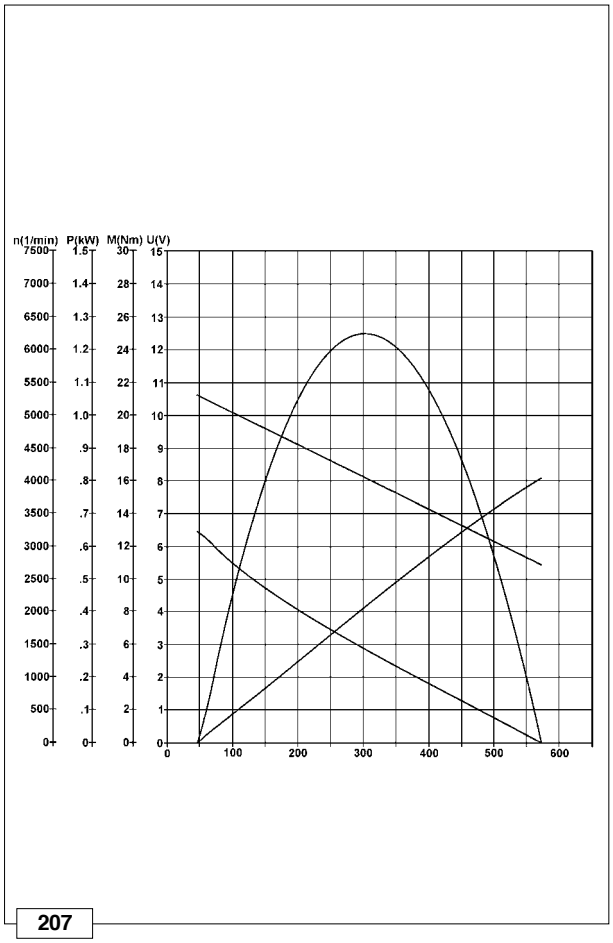
206

STARTER MOTOR - Bosch DW 12V 1,1 KW

Rotation: Clockwise

A = 17,5÷19,5 mm
(distance from starter mounting flange to ring gear face)

Note: Please refer to your local BOSCH distributor for service parts, repair criterion and warranty service.

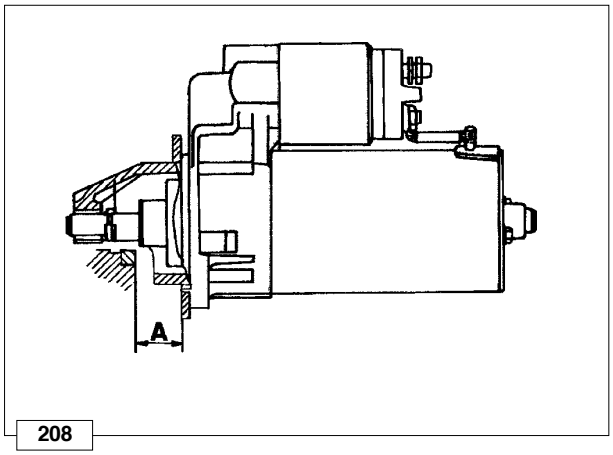


207

Starter motor, Bosch DW 12V 1,1 KW - Performance Curve

The curve was obtained at room temperature of -20°C with a fully charged 66Ah battery.

U = Starter Motor Voltag
n = Armature r/min
I = Absorbed Amperage
P = Starter Output Power (KW)
M = Starter Output Torque (Nm)



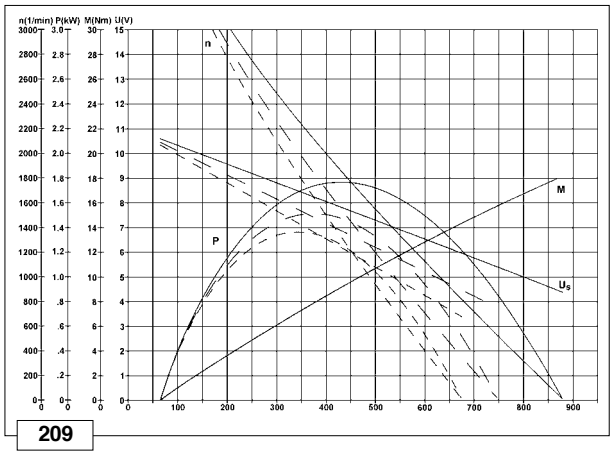
208

Starter motor, Bosch 12V 1,6 Kw

Rotation: Clockwise

A = 29,50÷31,5 mm
(distance from starter mounting flange to ring gear face)

Note: Please refer to your local BOSCH distributor for service parts, repair criterion and warranty service.

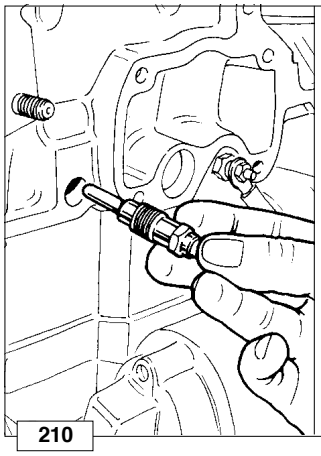


209

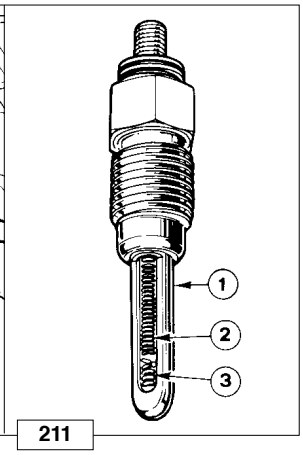
Starter motor, Bosch DW 12V 1,6 KW - Performance Curve

The curve was obtained at room temperature of -20°C with a fully charged 88 Ah battery.

U = Starter Motor Voltag
n = Armature r/min
I = Absorbed Amperage
P = Starter Output Power (KW)
M = Starter Output Torque (Nm)



210



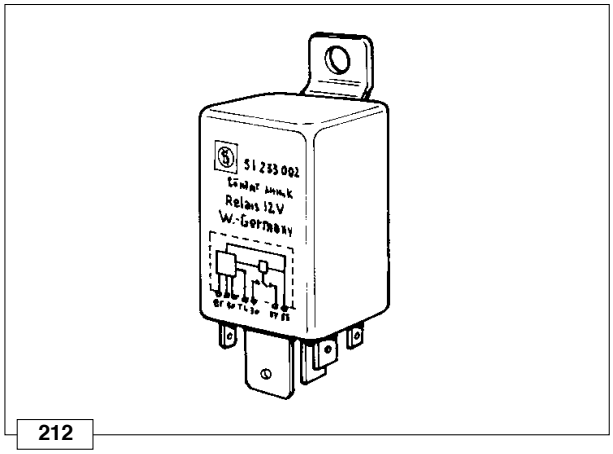
211

Pre-heating glow plug

Characteristics:
Nominal voltage 12,5V
Current absorption ..... 12A÷14A after 5 seconds
Sheath surface temperature ..... 850°C after 5 seconds.

Components:
1 Sheath
2 Primary Heating Coil
3 Secondary Heating Coil

❍ When remounting tighten at a torque of 20 Nm.



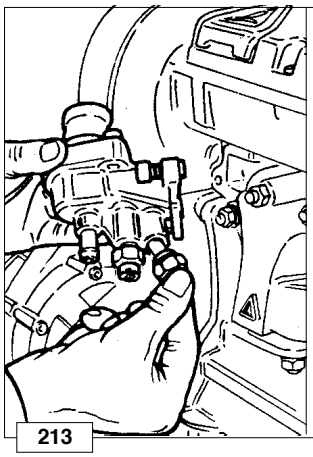
212

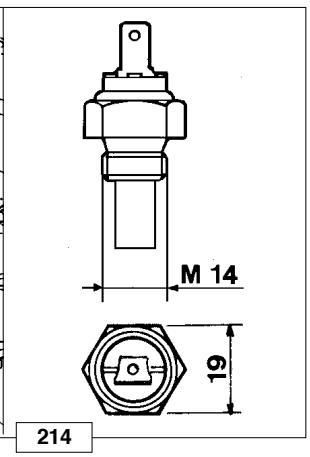
Pre-heating plug control unit with coolant temperature sensor

To avoid white smoke immediately following start-up post-heat for about 5 seconds, see table

Thermistor input		Glow-plug heat time (sec.)	
Resistance (ohm)	**Coolant temp. °C**	**Pre-heat**	**Post-heat**
7000 2400 100 460	-20 0 +20 +40	23.5÷29.5 13.5÷16.5 8.5÷10.5 6.0÷8.0	4.0÷7.0
≤ 320	+50	Heating stop	

➲ For electrical connections see figures 196-199-203.


213



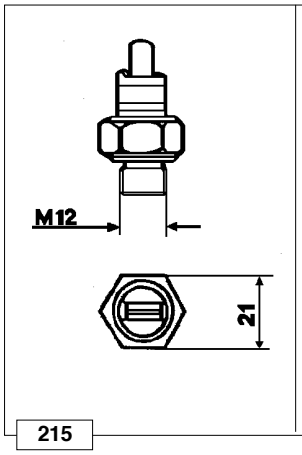
214

Temperature sensor for control unit

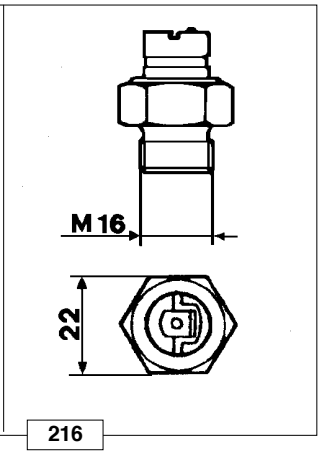
In engines fitted with the above-mentioned type of control unit, the introduction of the glow plugs depends on a temperature sensor that varies preheating temperature in relation to the coolant temperature.

Characteristics:

Temperature range ..... -30 ÷ +50°C
Voltage range ..... 6÷24 V
Temperature max. ..... 150°C
Max. tightening torque. ..... 30 Nm.



215



216

Oil pressure switch (Fig. 215)

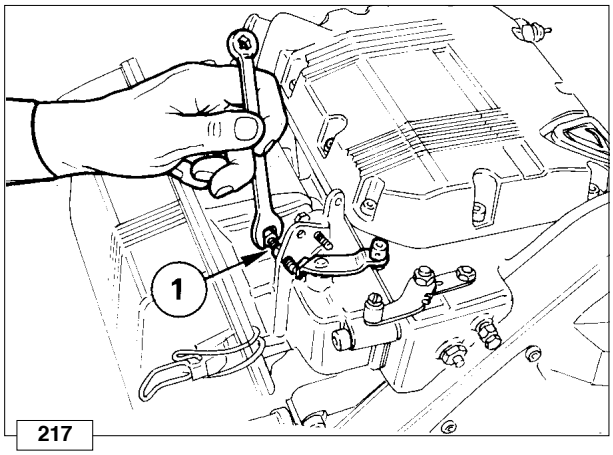
Characteristics:
Opening pressure: 0,15÷0,45 bar (for gen-sets: 1,4 bar).

❍ Tightening torque 25 Nm.

Coolant high temperature lamp sensor (Fig. 216)

Characteristics:
Circuit ..... single pole
Voltage range ..... 6÷24 V
Max. Power Absorption ..... 3 W
Closing temperature ..... 107÷113°C

❍ Tightening torque 25 Nm.



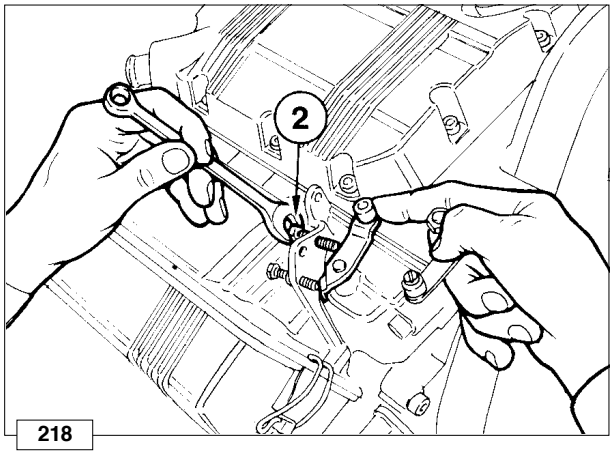
217

SPEED SETTINGS

Setting the idle minimum (standard)

After filling the engine with oil, fuel and coolant, start it and let it warm up for 10 minutes.
Turn the screw 1 to adjust the idle speed at 850 to 900 rpm.
Tighten then the locknut.

Note: If you loosen screw **1** speed decreases. To the opposite direction speed increases.

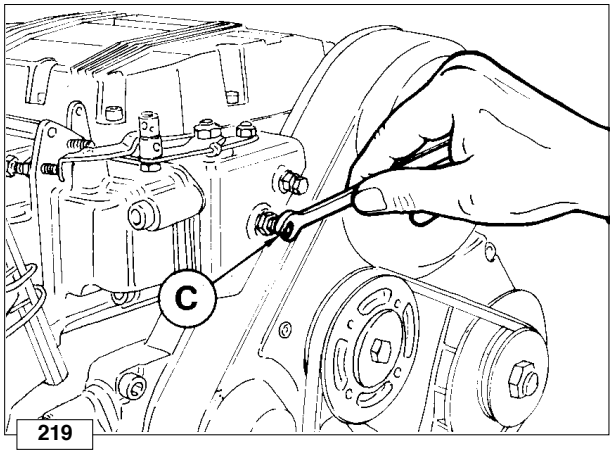


218

Setting the idle maximum (standard)

After setting the idle speed turn screw **2** and regulate the idle maximum at 3800 rpm.
Block then the locknut.
When the engine reaches its setting power, the maximum rpm will stabilise at 3600 rpm.

Note: If you loosen screw **2** speed increases.
To the opposite direction speed decreases.



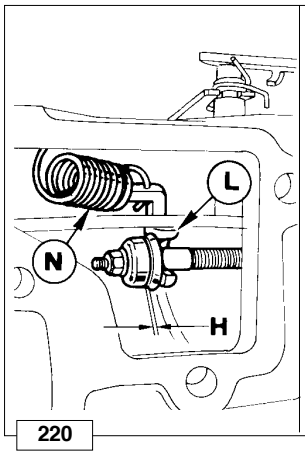
219

Pump injection delivery standard setting without dynamometric brake

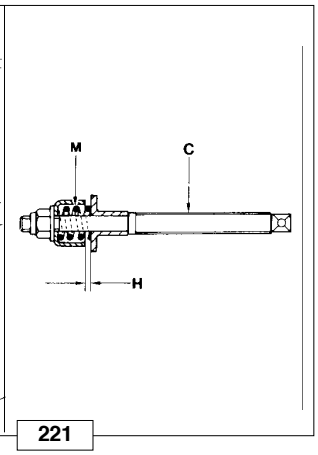
This adjustment must be performed with the dynamometric braked engine.
Without this the regulation is approximate.
In this case proceed as follows:

- Unlock the maximum flow limiter lock nut.
- Fully screw in flow limiter **C**.
- Run the engine to the maximum speed, that is 3800 rpm.
- Loosen flow limiter **C** until the engine revs start to decrease.
- Screw flow limiter **C** by 2.5 turns.
- Tighten the lock nut.

Note: If the engine under maximum load emits too much smoke unscrew **C**. Tighten **C** if at this load there is no smoke and if the engine does not reach its maximum power.



220

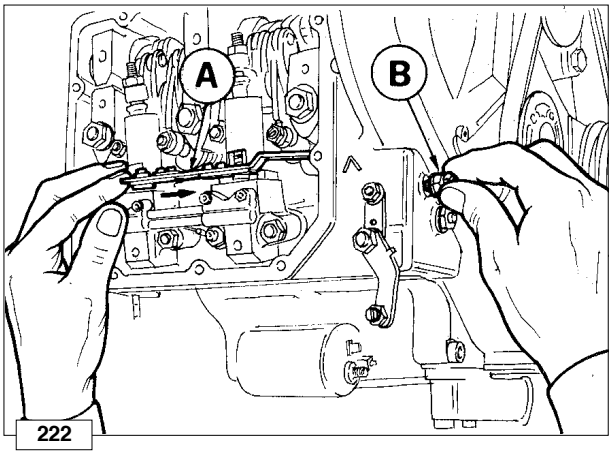


221

Injection pump flow limiter and engine torque gearing device

Flow limiter **C** has the function of limiting the injection pump's maximum delivery.
The same mechanism acts also as a torque gearing device. Indeed, under torque, spring **N** operating lever **L** overcomes the resistance of spring **M** located in the plunger barrel.
The stroke **H** that the torque gearing device allows to be carried out by lever **L**, will increase the injection pump delivery and the torque will hit its maximum value.

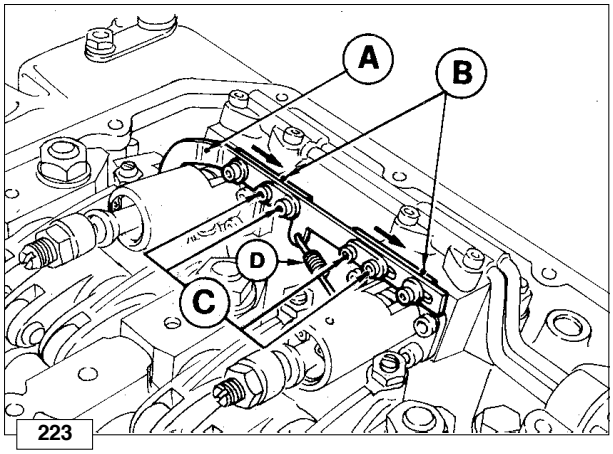
Important
The stroke H varies depending on which engine torque gearing device is fitted on the engine.



222

Setting the stop

Remove the rocker arms cover and completely unloosen screw **B**.
Push rod **A** to the right and keep it in this position; see figure.
Tighten screw **B** until it touches rod **A**.
Release rod **A** and tighten again screw **B** by a 0.5÷1.0 turn.
Tighten the lock nut.

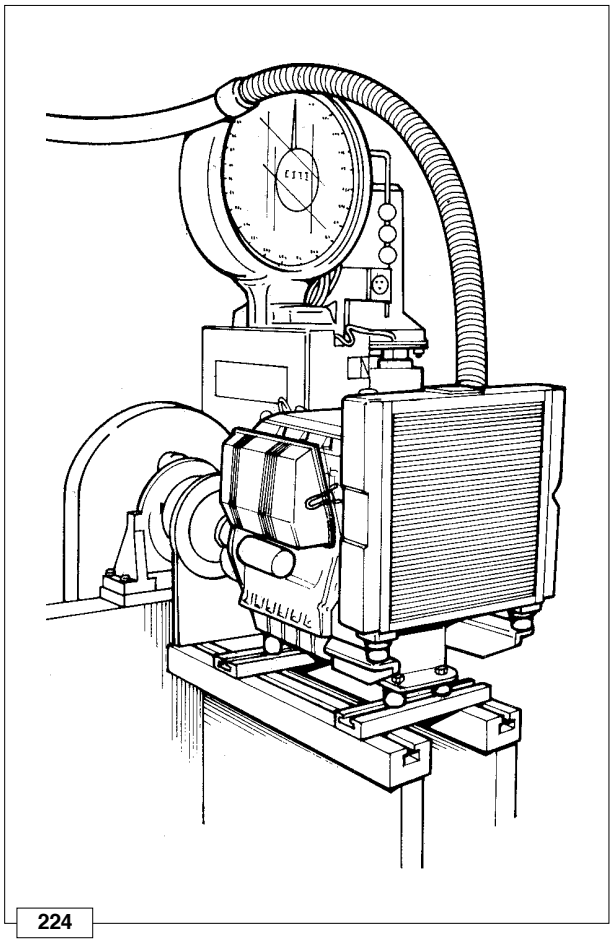


223

Pump/injector unit timing with speed governor

- Loosen the screws **C** of each pump/injector unit.
- If it is not connected, connect spring **D** to rod **A** (with this operation the speed governor blocks are closed).
- Move plates **B** of each pump/injector unit rightwards; see figure (with this operation the pumps/injector unit are at their maximum delivery).
- Tighten screws **C** at 1.1 Nm. Re-balance the deliveries.

Note: Spring **D** is the start-up fuel supplement spring: with the engine stopped pull rod **A** to the right by bringing the pump/injector unit delivery to the maximum value, until the speed governor comes into operation with the engine running


224

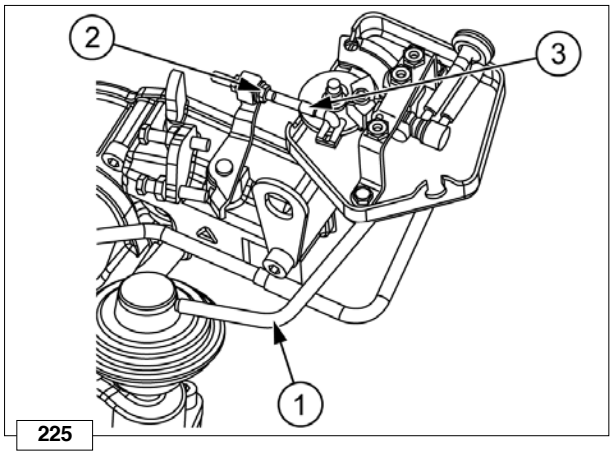
Pump/injector unit delivery setting with braked engine

1) Run the engine to the maximum speed.
2) Screw flow limiter **C** (see fig. 219).
3) Load the engine up to the power and number of revs required by the application's manufacturer.
4) Check that consumption is within the values allowed for in the settings table (see below).
If consumption is not within the given figures, it is necessary to change the balance conditions shown to the brake, altering the load and the speed governor. Redo the consumption check on the stabilised engine.
5) Unscrew limiter **C** until the engine rpm start to decrease. Lock the limiter using the lock nut.
6) Completely release the brake and check the rpm at which the engine stabilises.
The performance of the speed governor must meet the class required by the application's manufacturer.
7) Stop the engine.
8) Recheck the valve clearance with the engine cold.

~~Required settings (as most commonly applies)~~

~~* Refers to power curve NB, see pages 18÷20 and after run in.~~

~~Engine~~	~~Rpm~~	~~Power* (NB curve)~~	~~Specific fuel consumption~~	
		~~Kw~~	~~Time (sec) per 100 cm³~~	~~g/Kwh~~
~~502~~	~~2200~~	~~5,51~~	~~192÷183~~	~~285÷299~~
	~~3600~~	~~7,72~~	~~120÷115~~	~~326÷340~~
~~602~~	~~2200~~	~~7,35~~	~~155÷147~~	~~265÷279~~
	~~3600~~	~~9,92~~	~~93÷89~~	~~326÷340~~
~~903~~	~~2200~~	~~11,08~~	~~105÷99~~	~~261÷274~~
	~~3600~~	~~15,06~~	~~60÷58~~	~~328÷342~~
~~1204~~	~~2200~~	~~14,78~~	~~79÷75~~	~~258÷272~~
	~~3600~~	~~20,22~~	~~45,8÷44~~	~~326÷340~~
~~1204/T~~	~~3600~~	~~29,50~~	~~36÷35~~	~~284÷290~~



225

E.G.R. calibration

Mount a T-branch on vacuum valve - E.G.R. valve connection pipe (**1**), and connect it to a vacuum pressure gauge with 1 bar bottom scale so as to be able to read the degree of vacuum within the pipe.

Note: It is also possible to use a mercury column, 1 metre long, since the maximum suction pressure exerted by the vacuum pump is 720 mmHg.

Adjust the position of the accelerator lever via the regulator block, so that the internal adjusting nut (**2**), is about 5 mm from the end of the thread.

Accelerate the engine up to 3.600 rpm (with valve closed: this means that the value showed on the vacuum pressure gauge or on the mercury column should be 0.
In case it is different from zero, adjust the regulator block nuts to move it, in relation to the rod (**3**), in the direction that goes from the flywheel to the timing.

With the brake at a braking curve N=constant, “load” the engine slowing it down to 2.800 rpm.

Acting on the accelerator look for the E.G.R. valve closing point (pressure of the vacuum pressure gauge or mercury gauge equal to zero).

Note: Pay attention to determine the precise closing point: by slightly accelerating the engine the vacuum value in the E.G.R. operation pipe should immediately increase.

Measure the engine consumption in order to calculate the mm3/stroke value.

If the calculated value is less than 18.8 mm^3/stroke, adjust the adjusting nut making it closer to the end of the rod (**3**) to “increase the calibration”.

When the required value of 18.8 mm^3/stroke has been reached (and a power of around 7 KW) tighten the adjusting nuts.

ENGINE STORAGE (NOT INSTALLED)

- If the engine is not to be used for long periods, check the storage environment, the type of packaging and make sure these conditions will allow proper maintenance. If necessary, cover the engine with protective sheeting.

- Do not store the engine directly on the ground, in damp environments, in areas exposed to the elements, near sources of danger, including less visible hazards such as high-voltage power lines, etc.

Caution - Warning

If the engine is not to be used for more than 1 month, it is necessary to apply protective measures that are valid for 6 months (see "Protective treatment").

Important

If, after the first 6 months, the engine is still not to be used, it is necessary to carry out further measures to extend the protection period (see "Protective treatment").

PROTECTIVE TREATMENT

1 - Check that the engine oil and coolant are up to level.
2 - Fill up with fuel containing 10% AGIP RUSTIA NT
3 - Run the engine at minimum idle speed for 15 minutes.
4 - Switch off the engine.
5 - Remove the lubrication oil.
6 - Fill the sump with protective oil: AGIP RUSTIA C.
7 - Start the engine and check for fuel and oil leaks.
8 - Bring the engine to ¾ of the maximum speed for 5-10 minutes.
9 - Switch off the engine.
10 - Empty the fuel tank completely.
11 - Spray SAE 10W oil on the exhaust and intake manifolds.
12 - Close all openings to prevent foreign bodies from entering.
13 - Thoroughly clean all external parts of the engine using suitable products.
14 - Treat non-painted parts with protective products (AGIP RUSTIA 100/F).
15 - Loosen the alternator/fan belt.
16 - If necessary, cover the engine with protective sheeting.

Caution - Warning

In countries in which AGIP products are not available, find an equivalent product.
AGIP RUSTIA NT: MIL-L-21260 P10, grade 2
AGIP RUSTIA C: MIL-L-644-P9
AGIP RUSTIA 100/F: MIL-C-16173D.

Important

After a year of engine inactivity, the coolant loses its properties and must be replaced.

PREPARING THE ENGINE FOR OPERATION AFTER PROTECTIVE TREATMENT

After a period of inactivity and before installing and running the engine, it is necessary to carry out a few measures in order to ensure that it runs at maximum efficiency.

1 - Remove the protective sheeting.
2 - Eliminate any blockages in the exhaust and intake ducts.
3 - Use a cloth soaked in degreasing product to remove the external protective treatment.
4 - Remove the intake manifold.
5 - Inject lubrication oil (no more than 2 cm^3) into the valves and install the intake manifold.
6 - Adjust the alternator/fan belt tension.
7 - Turn the flywheel manually to check the movement of the mechanical parts.
8 - Refill the tank with fresh fuel.
9 - Start the engine and run at ¾ of the maximum speed for 5-10 minutes.
10 - Switch off the engine.
11 - Remove the protective oil to replace with engine oil.
12 - Introduce new oil (see “Lubricants”) up to the correct level marked on the dipstick.
13 - Replace the filters (air, oil, fuel) with original spare parts.
14 - Empty the cooling circuit completely and pour in the new coolant up to the correct level.

Caution - Warning

Over time, a number of engine components and lubricants lose their properties, even when the engine is not in use, and so it is important to consider whether they need replacing, based not only on the mileage, but also on age and wear.

15 - Install the engine and make the necessary connections and unions.
16 - Make sure that electrical contacts are intact and efficient.
17 - Check that the engine oil and coolant are up to level.
18 - Start the engine and keep at minimum speed for a few minutes.
19 - Check for leaks and, if necessary, find and eliminate the cause.
20 - Switch off the engine.
21 - Double check that the engine oil and coolant are up to level.

Table of tightening torques for the main components				
POSITION	**Riference (figure and page n°)**	**Diam. & pitch (mm)**	**Torque (Nm)**	**Sealant**
Injection pump control rod	62÷63 - p. 44	M 3 spec.	1,1	
Connecting rod ****	116 - p. 58	8x1	40	
Union for the nozzle (LDW 1204/T)	131÷132 - p. 61	8x1,25	12	
Glow-plugs	210÷211 - p. 92	12x1,25	20	
Oil filter cartridge (M 20x1,5 union)		20X1,5	15	270
Camshaft bearing (M 6 screws)		6	10	270
Rocker arm cover	55 - p. 43	6x1	9	638
Main bearing caps	126÷130 - p. 60	M 10	60	
Oil pan	97÷98 - p. 52	M 6	10	Silicon 7091
Camshaft bearing support screw	50 - p. 41	M 6	10	
Glow-plug cable nuts		5x0,8	5	
Fuel lift pump nuts	167 - p. 74	8x1,5	24	
Belt tensioner nut	39 - p. 38	M 10	40	
External Stop control lever nut		8x1,25	8	
Pump/injector unit fixing nut	181 - p. 79	M 8	20*	
Rocker arm assembly support nut	68 - p. 45	M 10	40	
Fuel pump cam	146 - p. 65	10x1,25	80	
Flywheel side oil seal ring flange		M 6	12	
Pre-combustion chamber ring nut	90÷96 - p. 51	30x1,5	**	
Vacuum pump fixing screws	13÷14 - p. 32	10x1,25	50	270
Belt tensioner		10	15	242
Crankcase		12x1,5		
Speed governor lever screw		6x1	7	
Driving pulley	22÷24 - p. 34	16x1,5 sin.	360	
Camshaft timing pulley	34 - p. 37	10x1,25	80	
Oil pressure switch	215 - p. 93	12x1,5	25	
Oil drain plug	152÷153 - p. 69	12x1,5	40	242
Cylinder headù	113÷115 - p. 57	18	***	
Injection pipe	64- p. 44	TCEI 4x1,5	4	
Flywheel	21 - p. 34	10x1,5	80	

* Tighten the two nuts that fasten each pump/injector unit at the same time. For engines with the injectors fixed with self-locking nuts, tighten the nuts at 23 Nm.

** Tighten these in two phases: the first phase at 100 Nm, the second phase at 180 Nm. See page 51, figures 95-96.

*** See page 57

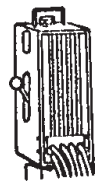
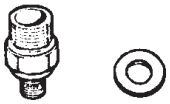
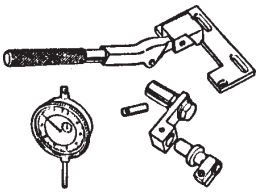
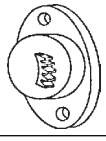
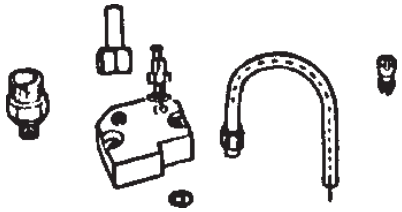
**** Aluminium connecting rod with 35 Nm tightening torque.

Table of tightening torques for standard screws (coarse thread)

Resistance class (R)								
Quality/ Dimensions								
Diameter	R>400N/mm²		R>500N/mm²		R>600N/mm²	R>800N/mm²	R>1000N/mm²	R>1200N/mm²
	Nm	Nm	Nm	Nm	Nm	Nm	Nm	Nm
M3	0,5	0,7	0,6	0,9	1	1,4	1,9	2,3
M4	1,1	1,5	1,4	1,8	2,2	2,9	4,1	4,9
M5	2,3	3	2,8	3,8	4,5	6	8,5	10
M6	3,8	5	4,7	6,3	7,5	10	14	17
M8	9,4	13	12	16	19	25	35	41
M10	18	25	23	31	37	49	69	83
M12	32	43	40	54	65	86	120	145
M14	51	68	63	84	101	135	190	230
M16	79	105	98	131	158	210	295	355
M18	109	145	135	181	218	290	405	485
M20	154	205	193	256	308	410	580	690
M22	206	275	260	344	413	550	780	930
M24	266	355	333	444	533	710	1000	1200
M27	394	525	500	656	788	1050	1500	1800
M30	544	725	680	906	1088	1450	2000	2400

Table of tightening torques for standard screws (fine thread)

Resistance class (R)								
Quality/ Dimensions								
Diameter	R>400N/mm²		R>500N/mm²		R>600N/mm²	R>800N/mm²	R>1000N/mm²	R>1200N/mm²
	Nm	Nm	Nm	Nm	Nm	Nm	Nm	Nm
M 8x1	10	14	13	17	20	27	38	45
M 10x1	21	28	26	35	42	56	79	95
M 10x1,25	20	26	24	33	39	52	73	88
M 12x1,25	36	48	45	59	71	95	135	160
M 12x1,5	38	45	42	56	68	90	125	150
M 14x1,5	56	75	70	94	113	150	210	250
M 16x1,5	84	113	105	141	169	225	315	380
M 18x1,5	122	163	153	203	244	325	460	550
M 18x2	117	157	147	196	235	313	440	530
M 20x1,5	173	230	213	288	345	460	640	770
M 20x2	164	218	204	273	327	436	615	740
M 22x1,5	229	305	287	381	458	610	860	1050
M 24x2	293	390	367	488	585	780	1100	1300
M 27x2	431	575	533	719	863	1150	1600	1950
M 30x2	600	800	750	1000	1200	1600	2250	2700

SPECIAL TOOLS	DESCIPTION	Part N°.
	Injection pumps delivery balancing instrument	7107-1460-127
	Precombustion chamber extractor	7107-1460-030
	Injection pump static injection advance tester(old type)	7271-1460-024
	Sheet metal for insertion of main bearings in the crankcase	7107-1460-053
	Ring nut wrench for fastening pump/injector pumping element	7107-1460-029
	Precombustion chamber wrench	7107-1460-027
	Precombustion chamber adjusting rod	7107-1460-031
	Coupling for static injection advance control and setting of old-type injection pumps injector	7107-1460-028
	Device for mounting valve guide gasket, intake and exhaust side	7107-1460-047
	Valve lowering device for injection advance control	7107-1460-048
	Timing belt tightening tool	7107-1460-049
	Crankshaft clamping tool	7107-1460-051
	Tool for injection advance control and setting of injector for pump/injector unit: se.no. 6590-272	7107-1460-056
	Tool for injection advance control and setting of injector for pump/injector unit: se.no. 6590-285, 6590-307, 6590-290	7107-1460-074

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

. .....

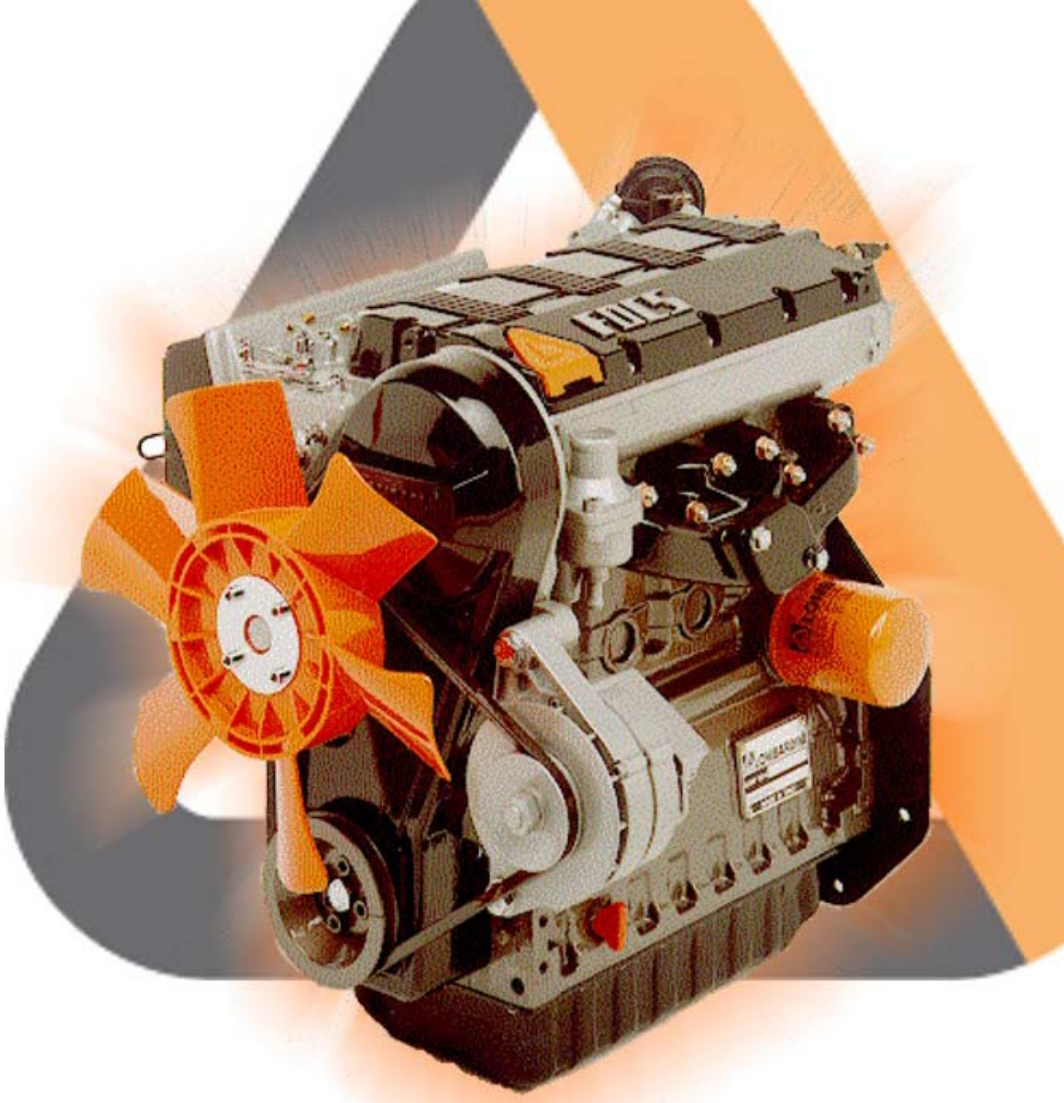
. .....

. .....

. .....

. .....

. .....



FOCS Engine Series

cod. 1-5302-351

La Lombardini si riserva il diritto di modificare in qualunque momento i dati contenuti in questa pubblicazione.
Lombardini se rèserve le droit de modifier, à n'importe quel moment, les données reportées dans cette publication.
Data reported in this issue can be modified at any time by Lombardini.
Lombardini vorbehält alle Rechte, diese Angabe jederzeit verändern.
La Lombardini se reserva el derecho de modificar sin previo aviso los datos de esta publicación.

LOMBARDINI
A KOHLER COMPANY

UNI EN ISO 9001 - cert. n° 0446
ISO/TS 16949 - cert. n° 3792

42100 Reggio Emilia – Italia - ITALY
Via Cav. del Lavoro Adelmo Lombardini, 2 - Cas. Post. 1074
Tel. (+39) 0522 3891 - Telex 530003 Motlom I – Telegr.: Lombarmotor
R.E.A. 227083 - Reg. Impr. RE 10875
Cod. fiscale e Partita IVA 01829970357 - CEE Code IT 01829970357

E-MAIL: atlo@lombardini.it
Internet: http://www.lombardini.it